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Hi Sam,

Here is the report presenting tables of drinking water concentrations and risks associated with specified dosages of the isotopes of interest. It was prepared by SC&A and reviewed by Cadmus (and ended up being an iterative, collaborative effort with considerable revision and improvement made since the last time we spoke). As we discussed, since this is only a draft we did not give it the “polish” of a final report (final proofreading, etc.). Our goal was to deliver as quickly as practicable a version with accurate and well-characterized numerical results.

We have annotated the report to highlight points that EPA may wish to consider going forward: e.g., alternative or additional analyses that could be performed.

We look forward to receiving your feedback. We will work with SC&A to implement any changes you wish to see, and upon receipt of technical direction we will merge this report with the “straw man” report delivered last year.

Best,

Brent

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DRAFT

TRIGGER LEVELS ASSOCIATED WITH ALTERNATIVE PROTECTIVE ACTION GUIDES FOR DRINKING WATER

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March 4, 2014

We would like to express our appreciation for the assistance provided by Dr. Joyce Lipsztein and Dr. Richard Leggett in the preparation of this report.

TABLE OF CONTENTS

Key Definitions	3
1.0 Introduction.....	6
2.0 Models and Assumptions	9
3.0 Model Input Parameters.....	11
3.1 Effective Dose Coefficients (Sv/Bq Ingested).....	11
3.2 Effective Whole Body Dose (Sv/Bq) to Offspring Due to Ingestion of Radionuclides by the Mother between Conception and Birth	11
3.3 Risk Coefficients (RCs)	12
4.0 Results – Examples	16
4.1 Example 1: Cs-137 Dose and Risk to an Infant (100 day old)	16
4.2 Example 2: Cs-137 Dose and Risk to an Adult	17
4.3 Example 3: Cs-137 Dose In Utero	17
5.0 Results – Complete Sets of Tables.....	19
References.....	21
Appendix 1: All Age Groups	22
Appendix 2: DEVELOPING EMBRYO AND FETUS*	25
Appendix 3: Infant	27
Appendix 4: 1 Year Old	29
Appendix 5: 5 Year Old.....	31
Appendix 6: 10 Year Old.....	33
Appendix 7: 15 Year Old.....	35
Appendix 8: Adult.....	37

KEY DEFINITIONS

Rad

A rad is the amount of absorbed radiation that delivers 100 ergs of energy per gram of absorbing medium.

For example, it is not unusual for a radionuclide to emit 1 MeV of photon or electron radiation each time it disintegrates. Since 1 MeV = 1.6E-6 ergs and the amount of energy required to break a chemical bond and create a free electron and a positively charged molecule (an ion pair) is typically about 30 to 40 eV, one rad will create about 2E12 ion pairs per gram of tissue exposed. These ion pairs are the cause of the damage associated with exposure to ionizing radiation, which at high whole body doses (>25 rad) can result in observable clinical damage, death at doses above about 400 rad, and a lifetime cancer risk of about between 0.0005 and 0.001 per rad delivered to the whole body.

rem and mrem

A rem is an expression of the amount of ionizing radiation absorbed by tissue multiplied by the a quality factor that takes into consideration the relative potential amount of damage the radiation might cause; a mrem (millirem) is 0.001 rem.

For example, for an internally deposited radionuclide, such as Cs-137, each time an atom of Cs-137 decays inside the body, it emits a certain amount of ionizing radiation in the form of beta particles (essentially electrons) and gamma rays (i.e., energetic photons). When this energy is deposited in tissue, the molecules that comprise living tissue are ionized, which results in an increased risk of cancer. The product of the absorbed dose to tissue (which is expressed in terms of rad) with the quality factor is referred to as the dose equivalent, expressed in units of rem or millirem. If 100 ergs per gram of any combination of beta particles or photons is deposited into a gram of tissue, the absorbed dose to the exposed tissue is 1 rad and the dose equivalent to that tissue is 1 rem. If the energy deposited in tissue is due to an alpha particle, the quality factor is 20 and the dose equivalent is 20 rem because the damage caused by the energy of an alpha particle in a gram of tissue is about 20 times greater than the same amount of energy of beta and photon radiation deposited in a gram of tissue is 20 times greater. If that energy is deposited uniformly in every gram of tissue in the body (whether alpha, beta or gamma), the exposure is defined as a whole body dose or effective dose.

Sv	A sievert (Sv) is 100 rem. Sv is the International System of Units (SI) derived unit of ionizing radiation dose (the rem and mrem are older, non-SI units).
Effective dose	When ionizing radiation is deposited in tissue, it can be deposited in only a small part of the body or uniformly throughout the body. The potential for harm associated with 1 rem (100 ergs/g) deposited in only a portion of the body is less than the potential for harm if the entire body experiences 1 rem. In order to establish risk equivalency between a partial and a whole body dose when only a portion of the body is exposed, the dose equivalent to the tissue experiencing the exposure is multiplied by a tissue weighting factor which converts the tissue dose to an effective whole body dose, or simply referred to as the effective dose. For example, if a person ingests I-131, most of the internal dose will be delivered to the thyroid gland. The tissue weighting factor for the thyroid gland is 0.04. This means that the risk of cancer from the exposure of only the thyroid gland is about 0.04 of the risk of cancer if that same dose was delivered to the entire body. Hence, if one rem is delivered to the thyroid gland due to the ingestion of I-131, the effective whole body dose is 0.04 rem. If Cs-137 is ingested, it is distributed to the whole body so there is no need to apply a tissue weighting factor because the whole body is uniformly exposed.
Ci, pCi, and dps	A curie (Ci) is an expression of the amount of radioactivity that corresponds to that amount of radioactive material (atoms or grams) that has a decay rate of 3.7E10 disintegrations per second (dps). A picocurie (pCi) is one trillionth (i.e., 10^{-12}) of a Ci.
Bq	One becquerel (Bq) is the amount of a radioactive material (atoms or grams) that decays at a rate of 1 disintegration per second.
DCF	Throughout this report, the terms dose and dose conversion factor (DCF) are used. If a person were to ingest a given radionuclide, the radionuclide might remain in his or her body for a long time. Hence, when we refer to a dose of 500 mrem delivered due to the ingestion of contaminated water for a one year period, the actual dose is the dose delivered to that person over his or her lifetime due to the radionuclides ingested in that year. Hence 500 mrem is actually 500 mrem lifetime dose commitment. Dose conversion factor, expressed in terms of Sv/Bq or mrem/Bq, actually is an expression of the lifetime dose commitment due to the ingestion of one Bq of a given radionuclide. If the Bq is ingested in one day or one year, that dose rate is referred to as 1 Bq/day or per

year, but the actual dose is delivered over a lifetime. For long lived radionuclides, like U-238, it could take an entire lifetime for uranium to be entirely cleared from the body. For relatively short-lived radionuclides, such as I-131, the iodine is entirely cleared in a relatively short period of time. It is still referred to as a lifetime dose commitment, but the dose is actually all delivered in a relatively short period of time because it decays away relatively quickly.

LET

Linear Energy Transfer (LET) is an expression of the energy lost by a charged particle per unit distance traveled in a material (in KeV per micron traveled in an absorbing medium), such as living tissue. In general, for the same amount of energy deposited in a gram of tissue, the damage caused by high LET radiation, such as alpha particles and neutrons, is much greater than that same amount of energy deposited by beta and photon radiation. The reason for the difference in potential damage is the number of ions produced per unit path traveled by the high LET particle is much denser than that for low LET radiation, making it more difficult for the body to repair the damage caused by the radiation. For example, the carcinogenic risks associated with a rad of alpha particle exposure is estimated to be about 20 times greater than a rad of beta or photon exposure.

1.0 INTRODUCTION

During the early stages of a radiological emergency, such as following an accident at a nuclear power plant or other type of incident where drinking water supplies could become contaminated with a variety of radionuclides, it may become necessary for emergency response personnel to interdict drinking water resources for some time period until there is assurance that the concentration of radionuclides in the drinking water resources have declined to an acceptable level, either through natural attenuation or treatment. As part of the planning process for such incidents, a relationship needs to be established between the concentration of a given radionuclide in a drinking water resource and the radiation dose and health risk members of the population might experience as a result of drinking contaminated water. This report presents the results of investigations that will help the U.S. Environmental Protection Agency (EPA) make judgments regarding when intervention might be needed.

A number of factors must be taken into consideration when making judgments regarding interdiction decision making. Of particular importance are the types of radionuclides of concern, the duration that members of the public might be exposed to contaminated drinking water, and the radiation dose and health risk that different members of a population might experience as a result of drinking water contaminated with radionuclides. In this particular investigation, the EPA has selected six radionuclides that require investigation, including Sr-90, Cs-137, and I-131, which are of particular interest with respect to nuclear power plant accidents, and Ir-192, Po-210, and Co-60, which are of interest because of their potential to be used in a dirty bomb or other incidents where drinking water resources might be contaminated. However, it is important to note that Sr-90, Cs-137, and I-131 are also of interest as radionuclides that might be used by terrorists or involved in some other type of incident where drinking water resources might be contaminated.

The concentration of a given radionuclide in drinking water that requires interdiction depends primarily on the radiation dose and health risk that members of an exposed population might experience. In this particular investigation, we are interested in the concentration of the above six radionuclides that could result in radiation exposures of 4, 10, 15, 25, 100, 250, 300, 400, and 500 mrem/yr.¹ These exposures were selected because they bracket the range of radiation exposures that might be of public health concern. For example, 4 mrem/yr is associated with the current drinking water standards as set for in 40 CFR 141. If radionuclides in drinking water resources are below the concentration that can result in a whole body dose below 4 mrem/yr, the water is considered safe for drinking by EPA. At the other extreme, 500 mrem, has been selected by the Food and Drug Administration (FDA) as the radiation dose where it is appropriate to interdict food that might become contaminated with radionuclides. Hence, this range of doses represents potential interdiction levels, or Protective Action Guides (PAGs), that might warrant interdiction of contaminated water supplies. It is noted that under some circumstances higher interdiction levels might warrant consideration, including 1 rem, 5 rem, and perhaps as high as 25 rem.

¹ These values are actually the lifetime effective dose commitment associated with radionuclides ingested during the course of year or any of the other ingestion time periods addressed in this report.

Interdiction decision making is complicated by the fact that, for the same quantity of a given radionuclide ingested in drinking water, different members of the public will experience different doses and health risks. For example, the dose and potential health risk that an adult might experience due to the ingestion of 1 Bq of a given radionuclide is different than the dose and health risk that a child might experience. In addition, since different members of the public consume different daily quantities of water, the amount of a given radionuclide that one member of the public might ingest in a day, such as an adult, will be different from the amount of that radionuclide that a child might ingest in a day for water containing the same concentration of a given radionuclide.

Ultimately, the radiation dose and health risk a given member of a population might experience from a given concentration of a radionuclide in drinking water will depend on the total amount of water consumed over the time period that the water resource is ingested. Hence, the radiation dose that a population might experience from drinking water contaminated with a given concentration of a radionuclide in water will be greater if the population is exposed for long periods of time, as opposed to short periods of time.

In light of these considerations, this report presents the concentrations of radionuclides in water and associated radiation health risks for the following array of circumstances and potential decision criteria (i.e., PAGs):

- Decision criteria or PAGs established at 4, 10, 15, 25, 100, 250, 300, 400, and 500 mrem/yr.
- Isotopes of interest: Sr-90, Cs-137, I-131, Ir-192, Po-210, Co-60.
- The dose and risk and conversion parameters contained in Federal Guidance Report 13 (FGR-13) (EPA 2002).
- Exposed subpopulations, including the embryo and fetus of pregnant women, infants, children, adults, elderly, and women of child bearing age. As discussed later in this report, dose conversion factors are not available separately for males or females or for pregnant women or the elderly in FGR-13 and International Commission on Radiological Protection (ICRP) publications . On the other hand, separate risk coefficients (RCs) are available for males and females and the elderly. With respect to the elderly, the dose commitment per unit intake of a given radionuclide is expected to be comparable to or less than the dose commitment per unit intake for other adults because of the shorter life expectancy of the elderly, which results in a shorter time period over which dose is delivered following intake. Hence, all other factors being equal regarding state of health and predisposition to cancer, if young adults are protected, so are the elderly. Rather than “children” generically, the sources support an evaluation of trigger levels and risks for 1 year olds, 5 year olds, 10 year olds, and 15 year olds.
- Consumption factors for exposure at different ages for each subpopulation as recommended in FGR 13. Since we were unable to make a distinction between males and females with respect to dose conversion factors, we had to make a choice regarding which drinking water values we should use: males, females, or the average for adults. In general, we chose to use the average for adults. However, in order to derive the doses to

the developing fetus, we used the water ingestion rate for pregnant women as provided in the *EPA Exposure Factors Handbook* (EPA 2011).

- Exposure durations of 30, 60, 90, and 365 days for each age group considered. In the case of the child in utero the maximum duration of the ingestion period for the pregnant women is 270 days because that is (approximately) the duration of the gestation period.

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2.0 MODELS AND ASSUMPTIONS

The fundamental equations that are used to derive trigger levels in this report are as follows.

The first step in the process is to derive the quantity of radionuclide i ingested by age group a over a given time period, T .

$$I_{iaT} = C_i \times Ing_a \times T$$

Where:

I_{iaT} = The total intake of radionuclide i for age group a (pCi or Bq) over time period T (days)

C_i = The concentration of radionuclide i in drinking water (pCi/L or Bq/L). In this analysis, the concentration of the radionuclide is assumed to be constant over the time period T of interest. In the real world, the concentration of a given radionuclide in water will likely vary widely over a given time period of interest, especially over long time periods.

Ing_a = The daily ingestion rate of water for age group a as provided in FGR-13 (L/day).

T = The time period that the population is drinking contaminated water (days). In this analysis, the time periods of interest are 30, 60, 90, and 365 days.

The effective whole body dose (mrem or Sv) due to the ingestion of radionuclide i to age group a over time period T is derived as follows:

$$D_{iaT} = I_{iaT} \times DCF_{ia}$$

Where:

D_{iaT} = Effective whole body dose (mrem or Sv) due to the ingestion of radionuclide i to age group a over time period T

I_{iaT} = The total intake of radionuclide i for age group a (pCi or Bq) over time period T

DCF_{ia} = The effective dose coefficient (also referred to as the whole body dose conversion factor or DCF) for the ingestion of radionuclide i in drinking water and age group a (mrem/Bq or Sv/Bq) using the DCFs from FGR-13.

Risk, in this report, is expressed in terms of total cancer risk (morbidity) as opposed to fatal cancer risk (i.e., mortality). The lifetime risk of cancer due to the ingestion of radionuclide i by age group a :

$$R_{iaT} = I_{iaT} \times RC_{ia}$$

Where:

R_{iaT} = The lifetime risk of cancer due to the ingestion of radionuclide i over time period T by age group a (life risk of cancer per Bq or per pCi ingested).

I_{iaT} = The total intake of radionuclide i for age group a (pCi or Bq) over time period T .

RC_{ia} = The lifetime risk coefficient for the ingestion of radionuclide i in drinking water and age group a [lifetime risk per pCi (or per Bq) ingested in water] using the RCs from FGR-13.

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3.0 MODEL INPUT PARAMETERS

3.1 Effective Dose Coefficients (Sv/Bq Ingested)

Table 1 presents the effective whole body dose per Bq ingested of each radionuclide in water by each age group. The values apply to both males and females because DCFs are not provided separately for males and females. All the FGR 13 values are the average values for males and females.

Table 1. Dose Conversion Factors

Isotope	DCF _s (Sv per Bq ingested at the age indicated) from FGR-13*					
	Infant (100 day old)	1 year old	5 year old	10 year old	15 year old	Adult
Sr-90	2.27E-07	7.24E-08	4.69E-08	5.97E-08	7.89E-08	2.77E-08
Y-90	3.13E-08	2.00E-08	9.97E-09	5.90E-09	3.34E-09	2.69E-09
Cs-137	2.11E-08	1.24E-08	9.69E-09	1.01E-08	1.34E-08	1.36E-08
I-131	1.84E-07	1.79E-07	1.04E-07	5.24E-08	3.42E-08	2.18E-08
Ir-192	1.34E-08	8.74E-09	4.59E-09	2.85E-09	1.71E-09	1.37E-09
Po-210	5.30E-06	1.79E-06	8.88E-07	5.25E-07	3.19E-07	2.45E-07
Co-60	5.43E-08	2.68E-08	1.69E-08	1.12E-08	7.94E-09	3.42E-09

* The values in this table were taken from the CD that accompanies FGR-13 (EPA 2002).

Doses on the order of 1E-5 to 1E-9 Sv/Bq imply that the ingestion of 1 Bq (i.e., the quantity of a radionuclide associated with 1 disintegration per second) is an extremely small quantity of radioactive material and is associated with a very small dose commitment.

For radionuclides like Po-210, which can be present in soluble or insoluble form in water, the DCFs for the soluble form are used because they have the higher DCFs and are more likely to reach receptors before they deposit or are filtered from the drinking water resource.

Although it is not among the six radionuclides of primary interest, Y-90 is also included in this table and other tables in this report because it is likely that Y-90, which is the progeny of Sr-90, will be present in equilibrium, or close to equilibrium, with Sr-90 in drinking water. If the Sr-90 is freshly separated, the Y-90 might not be initially present, because it has a 64-hour half-life, and it will take several weeks of growth before it achieves equilibrium with its parent, Sr-90. However, upon deposition in a drinking water resource, the Y-90 might already be present at levels close to equilibrium. The implications are that, when making use of these tables, a judgment will need to be made whether the DCFs and RCs for Sr-90 and Y-90 should be summed. However, since the DCFs and RCs for Y-90 are small compared to those for Sr-90, the additional dose or risk associated with Y-90 is small relative to that of Sr-90 and will not have a significant impact on interdiction decision making. The Y-90 values are provided here for completeness.

3.2 Effective Whole Body Dose (Sv/Bq) to Offspring Due to Ingestion of Radionuclides by the Mother between Conception and Birth

Table 2 presents the Dose Conversion Factors corresponding to the effective whole body dose that will be experienced by the offspring while in utero and after birth due to the ingestion of the indicated radionuclides by the mother from conception to birth. More precisely, these values represent the doses (in Sv) that the offspring will experience in utero and from age 0 to 70 if the mother ingests 1 Bq of the indicated radionuclide during the course of the 9-month period from conception to birth of the child. The dose conversion factors apply to both male and female offspring. The results presented in Appendix 2 were calculated using the “in utero” dose conversion factors only, representing the dose incurred by the offspring before birth. Alternatively, the “in utero” and “after birth” values could be summed to enable calculation of a total lifetime dose.

Table 2. Dose Conversion Factors for Offspring Exposed in Utero

Isotope	DCFs (Sv per Bq ingested by mother during pregnancy) from ICRP 88*	
	In Utero	After Birth through the Age of 70
Sr-90	2.8E-08	1.5E-08
Y-90	Not available	Not available
Cs-137	5.2E-09	4.8E-10
I-131	2.1E-08	2.1E-09
Ir-192	Not available	Not available
Po-210	1.1E-07	2.0E-08
Co-60	1.5E-09	4.1E-10

Source: ICRP 2012

This rather unique subject has been discussed in two relatively recent reports:

- NCRP 2013. “Preconception and Prenatal Radiation Exposure: Health Effects and Protective Guidance,” NCRP Report No. 174. National Council of Radiation Protection and Measurement.
- ICRP 2001. *Doses to Embryo and Fetus from Intakes of Radionuclides by the Mother*. ICRP Publication 88. Oxford, Pergamon Press.

A review of these documents helps to enrich our understanding of this important issue. It is quite conceivable that a woman might ingest radionuclides in water (or by inhalation or the ingestion or food) and accumulate a body burden before becoming pregnant. At the time of pregnancy, the radionuclides present in the woman’s body can result in exposure of the developing embryo (conception to 8 weeks) and the developing fetus (from week 8 until birth) (ICRP 2001, Section 4.20.2, pg. 228). Of course, while the woman is pregnant, radionuclides ingested by the woman can expose the embryo and developing fetus to varying degrees. This report explicitly considers these exposure scenarios as part of investigations into alternative PAGs and trigger levels. Note, however, that the limiting exposure would occur if the woman ingests radionuclides while she is pregnant. Hence, this report is limited to that aspect of this exposure scenario.

3.3 Risk Coefficients (RCs)

Table 3 presents, for different isotopes and different age groups, the lifetime risk of cancer (fatal plus nonfatal) per Bq ingested in water at that age. If the isotope could exist in organic vs. inorganic form, inorganic was assumed. The values presented here apply to both males and

females. However, in the case of these RCs, separate values can be developed for males and females, if so desired. (Risk Tab Ver. 2.2.1, the source of the information in the table, presents risk conversion factors for both males and females and for both--i.e., the average of the two values. We used the average. We could develop a separate set of risk tables for males and females and also a separate set for morbidity and mortality.)

Table 3. Lifetime Morbidity Risk Conversion Factors (per Bq ingested in water at the indicated age)

Isotope	In utero	Infant	1 yr old	5 yr old	10 yr old	15 yr old	Adult (age 25-70)
Sr-90	not available	1.35E-08	8.59E-09	5.13E-09	3.21E-09	3.36E-09	1.10E-09
Y-90	not available	1.11E-08	8.08E-09	4.25E-09	2.54E-09	1.44E-09	1.13E-10
Cs-137	not available	3.40E-09	2.49E-09	1.97E-09	1.99E-09	2.44E-09	6.17E-10
I-131	not available	2.15E-08	1.99E-08	1.06E-08	5.04E-09	2.96E-09	4.58E-10
Ir-192	not available	4.12E-09	3.04E-09	1.65E-09	1.01E-09	5.94E-10	5.34E-11
Po-210	not available	1.77E-07	9.51E-08	5.15E-08	3.18E-08	1.95E-08	6.73E-09
Co-60	not available	7.52E-09	5.22E-09	3.30E-09	2.16E-09	1.42E-09	1.33E-10

These values were taken from Risk Tab Ver. 2.2.1 by K.F. Eckerman & N.S. Nelson (Nov. 8, 2012).

The term morbidity risk is an expression of the probability that the individual will contract a cancer during his or her lifetime. Risk conversion factors express the additional lifetime risk of cancer a person might experience as a result of ingesting one Bq of a radionuclide. As may be noted, the additional cancer risks associated with the ingestion of 1 Bq is extremely small relative to the lifetime risk of cancer due to other (often unknown) causes. Note that the lifetime risk of cancer per Bq ingested is higher for young people than for old people.

Risk conversion factors for the developing embryo and developing fetus are not available from Risk Tab Ver. 2.2.1 or any other source consulted. Therefore, although the risk for exposure in the womb may be non-zero, we are unable to quantify it.

3.4 Water Ingestion Rate

Two sources were used to derive ingestion rates, FGR-13 (EPA 2002) and the *EPA Exposure Factors Handbook: 2011 Edition* (EPA 2011).

Table 4 presents the mean values for tap water consumption taken from Table 3-1 of FGR-13 (EPA 2002). Values are provided for males and females in various age groups. Most of the ingestion values used in this report were taken from this table, which was designed to be used in conjunction with other data from FGR-13. Since the ingestion rates for males are higher (and therefore more conservative) than those for females, we elected to use the values for males to represent each age group. We could have used the average drinking water value for each age group, but then that would have underestimated the doses for males. If so desired, we can derive separates tables of risks for males and females.

Table 4. Drinking Water Ingestion Rates from FGR-13

Age (years)	Tap Water (L/day)*	
	Male	Female
0	0.191	0.188
1	0.223	0.216
5	0.542	0.499
10	0.725	0.649
15	0.900	0.712
20	1.137	0.754
50	1.643	1.119
75	1.564	1.179

*Values Extracted from EPA 2002, Table 3.1.

Table 5 presents the drinking water ingestion rates provided in “The Executive Summary” of the *EPA Exposure Factors Handbook: 2011 Edition* (EPA 2011). This table provides both mean and 95th percentile ingestion values for individuals (males and females aggregated) in various age groups, as well as in special cohorts such as pregnant and lactating women. The mean ingestion rate for pregnant women from this table (i.e., 0.819 L/day, which is slightly higher than for non-pregnant women) was used to calculate trigger levels for the developing fetus in Appendix 2 of this report.

**Table 5. Per Capita Drinking Water Ingestion Rates from
EPA Exposure Factors Handbook (2011)**

Age	Mean mL/day	95 th percentile mL/day
Children		
Birth to 1 month	184	839*
1 to <3 months	227*	896*
3 to <6 months	362*	1,056
6 months to <12 months	360	1,055
1 to <2 years	271	837
2 to <3 years	317	877
3 to <6 years	327	959
6 to <11 years	414	1,316
11 to <16 years	520	1,821
16 to <18 years	573	1,783
18 to <20 years	681	2,368
Adults		
>21 years	1,043	2,958
>65 years	1,046	2,730
Pregnant women	819*	2,503*
Lactating women	1,379*	3,434*

* Estimates are less statistically reliable, based on guidance published in NCHS 1993.

An important judgment needs to be made whether the trigger levels and risks provided in this report are for use in protecting the average member of a given age group or the 95th percentile members of a given age group. We used the mean drinking water values, which means that some people will experience slightly higher doses and risks and some will experience slightly

lower doses and risks. If the 95th percentile drinking water values from Table 5 were to be used, 95% of the population would be protected at the indicated levels. Finally, other values in the calculation, including the effective dose coefficients and risk conversion factors, have a degree of uncertainty and individual variability. The values used in this report are those recommended by the EPA in FGR-13 and represent a best estimate for a given population group. The uncertainty and individual variability in these values are described in the published literature.

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4.0 RESULTS – EXAMPLES

Using the models described in Section 2 and the input parameters in Section 3, we can derive the trigger levels and lifetime cancer risks associated with the ingestion of the six radionuclides in water (Sr-90, Cs-137, I-131, Ir-192, Po-210, and Co-60) for the different age groups, alternative PAGs (4, 10, 15, 25, 100, 250, 300, 400, and 500 mrem/yr), and the four different exposure time periods (30, 60, 90, and 365 days). These calculations are best performed using a spreadsheet. However, to aid the reader (and as part of the quality assurance check on the spreadsheet values), we will first perform selected calculations by hand for Cs-137. In these example calculations, the PAG is 500 mrem/yr and the time period of exposure is assumed to be 1 year.

4.1 Example 1: Cs-137 Dose and Risk to an Infant (100 day old)

Let us assume that a PAG is set at 500 mrem/yr (5 mSv or 0.005 Sv) and we are concerned with protecting an infant (100 day old) who might consume contaminated drinking water for 1 year. As described in Section 2, the basic equation used to perform this calculation is as follows:

$$D_{iaT} = C_i \times Ing_a \times T \times DCF_{ia}$$

Where:

D_{iaT} = Effective whole body dose (mrem or Sv) due to the ingestion of radionuclide i to age group a over time period T .

DCF_{ia} = The effective dose coefficient (or effective whole body DCF) for the ingestion of radionuclide i in drinking water and age group a (mrem/Bq or Sv/Bq) using the DCFs from FGR-13.

C_i = The concentration of radionuclide i in drinking water (pCi/L or Bq/L). In this analysis, the concentration of the radionuclide is assumed to be constant over the time period T of interest. In the real world, the concentration of a given radionuclide in water will likely vary widely over a given time period of interest, especially if long time periods are involved.

Ing_a = The daily ingestion rate of water for age group a as provided in FGR-13 (L/day).

T = The time period that the population is drinking contaminated water (days). In this analysis, the time periods of interest are 30, 60, 90, and 365 days.

The equation takes the following form when deriving the radionuclide concentrations:

$$C_i = D_{iaT} \div (Ing_a \times T \times DCF_{ia})$$

Where:

D_{iaT} = 0.005 Sv (or 500 mrem)

Ing_a = 0.191 L/day for a male 100 day old child

T = 365 days

DCF_{ia} = 2.11E-08 Sv/Bq ingested

$C_i = 0.005 \text{ Sv} \div (0.191 \text{ l/day} \times 365 \times 2.11\text{E-}08 \text{ Sv/Bq}) = 3,399 \text{ Bq/L} = 91,773 \text{ pCi/L}$

Hence, the trigger level would be 3,399 Bq/L, or 91,773 pCi/L, of Cs-137.

The lifetime risk of cancer to the child associated with this intake of Cs-137 in water is derived as follows:

$$R_{iaT} = I_{iaT} \times RC_{ia}$$

Where:

- R_{iaT} = The lifetime risk of health detriment due to the ingestion of radionuclide i by age group a over time period T .
- I_{iaT} = The total intake of radionuclide i for age group a (pCi or Bq) over time period T . (Calculated as the drinking water concentration, C_i in the previous equation, multiplied by the water ingestion rate, in this case for a newborn male from Table 4 above, multiplied by the time period, in this case 365 days.)
- RC_{ia} = The lifetime risk coefficient for the ingestion of radionuclide i in drinking water and age group a [lifetime risk per pCi (or per Bq) ingested in water] using the RCs from FGR-13. Risk is expressed in terms of total cancer risk (morbidity), as opposed to fatal cancer risk (i.e., mortality).
- R_{iaT} = $3,399 \text{ Bq/L} \times 0.191 \text{ L/day} \times 365 \text{ days} \times 3.40\text{E-}09/\text{Bq} = 8.06\text{E-}04$ lifetime risk of cancer.

4.2 Example 2: Cs-137 Dose and Risk to an Adult

Performing the same exercise, we obtain the following results:

$$C_i = D_{iaT} \div (I_{ng_a} \times T \times DCF_{ia})$$
$$C_i = 0.005 \text{ Sv} \div 1.137 \text{ L/day} \times 365 \text{ days} \times 1.36\text{E-}08 \text{ Sv/Bq} = 886 \text{ Bq/L} = 23,922 \text{ pCi/L}$$
$$R_{iaT} = 886 \text{ Bq/L} \times 1.137 \text{ L/day} \times 365 \text{ days} \times 6.02\text{E-}10/\text{Bq} = 2.2\text{E-}04 \text{ lifetime risk of cancer}$$

Note that the concentration of Cs-137 in drinking water that is associated with a dose of 500 mrem for 1 year of exposure to a child is 3,399 Bq/L, while the concentration of Cs-137 in drinking water that results in 500 mrem to an adult from 1 year of exposure is 886 Bq/L. Hence, in order to achieve the same dose-based PAG, the concentration of Cs-137 in water must be about 3.8 times lower in order to protect an adult as opposed to a child (0–1 year old). This unexpected result is due to the fact that, even though the DCF for a child is about 1.6 times higher, adults ingest much larger quantities of water (1.137 versus 0.191 L/day). Therefore, the dose to the adult is limiting in this example.

4.3 Example 3: Cs-137 Dose In Utero

Performing the same exercise for in utero dose calculations, we obtain the following results:

$$C_i = D_{iaT} \div (I_{ng_a} \times T \times DCF_{ia})$$

$$C_i = 0.005 \text{ Sv} \div (0.819 \text{ L/day} \times 270 \text{ days} \times 5.2\text{E-09} \text{ Sv/Bq}) = 4,348 \text{ Bq/L} = 117,396 \text{ pCi/L}$$

An estimate of risk to the developing fetus is not provided for the reasons described elsewhere in this report.

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5.0 RESULTS – COMPLETE SETS OF TABLES

In this section, we briefly describe and present the concentrations of radionuclides in water and associated lifetime risks of cancer for the following combination of alternative PAGs, isotopes, members of the exposed population, and time periods of exposure to contaminated water:

- PAGs established at 4, 10, 15, 25, 100, 250, 300, 400, and 500 mrem/yr.
- Isotopes of interest: Sr-90, Cs-137, I-131, Ir-192, Po-210, and Co-60.
- Exposed subpopulations: The data do not support analysis of all categories exactly as listed in the charge statement, but they support analysis that sheds at least some light on each category.
 - Embryo and fetus: Dose data are available for this population (with the exception of isotopes Y-90 and Ir-192); risk data are not. Ingestion rates for pregnant women are applied.
 - Infants: Dose data are available representing newborn infants (100 day old). Risk data representing both sexes in this age group are applied; drinking water ingestion rates for males in this age group are applied as more conservative than ingestion rates for females or the average.
 - Children: Dose data are available representing 1- 5-, 10-, and 15-year olds. Risk data representing both sexes in these age groups are applied; drinking water ingestion rates for males in these age groups are applied as more conservative than ingestion rates for females or the average.
 - Adults: Dose data are available for generic adults. Risk data representing both sexes in this age group are applied; drinking water ingestion rates for males in this age group are applied as more conservative than ingestion rates for females or the average.
 - Elderly: Dose data are not available specifically for the elderly population; general adult dose data may be consulted for the sake of comparison. The dose commitment per unit intake of a given radionuclide is expected to be comparable to or less than the dose commitment per unit intake for younger adults due to the shorter life expectancy after exposure and, therefore, the shorter time period over which dose is delivered following intake. Risk data and ingestion data for the elderly population are available (risk data for both sexes and ingestion rates for males would be applied, as in other population categories).
 - Women of child bearing age: Dose data are not available specifically for women of child-bearing age; general adult dose data may be consulted. Risk data and ingestion rates specific to this age and gender group are available and could be applied.
 - We also provide a set of tables with the results of the limiting age group for each radionuclide and each alternative PAG.
- Exposure durations of 30, 60, 90, or 365 days. (In the case of in utero exposure, a duration of 270 days, approximating full-term pregnancy, is used.)

We have organized the information into separate appendices, as follows:

Appendix 1 – All Age Groups: This appendix presents the most restrictive concentrations of radionuclides in water for each radionuclide and each alternative PAG. These are the lowest concentrations in water, among the different age groups, for each candidate PAG. Specifically, we sorted on the values of trigger levels among each age group that are most limiting (lowest concentration) for each isotope, each alternative candidate PAG, and each exposure duration. This appendix allows the user of these tables to quickly determine the trigger level for each radionuclide that is most protective for each candidate PAG, and each time period of exposure, and which age group is the limiting.

Appendix 2 – Developing Embryo and Fetus: This appendix presents the radionuclide concentrations in drinking water associated with specified doses for developing embryos and fetuses whose mothers consume the indicated radionuclides in drinking water over the specified time periods during gestation. (The figures represent only the dose incurred during gestation, not the lifetime dose that results from exposure in utero.) The longest ingestion period considered in this appendix is 270 days, or the approximate length of a full-term pregnancy. Note that trigger levels could not be calculated for Y-90 or Ir-192, and lifetime risks could not be calculated for any isotope in utero.

Appendix 3 – Infant (100 day old): This appendix presents the radionuclide concentrations in drinking water and associated lifetime risks for an infant who consumes the indicated radionuclides in drinking water over the specified time periods.

Appendix 4 – 1 Year Old: This appendix presents the radionuclide concentrations in drinking water and associated lifetime risks for a 1 year old who consumes the indicated radionuclides in drinking water over the specified time periods at that age.

Appendix 5 – 5 Year Old: This appendix presents the radionuclide concentrations in drinking water and associated lifetime risks for a 5 year old who consumes the indicated radionuclides in drinking water over the specified time periods at that age.

Appendix 6 – 10 Year Old: This appendix presents the radionuclide concentrations in drinking water and associated lifetime risks for a 10 year old who consumes the indicated radionuclides in drinking water at that age.

Appendix 7 – 15 Year Old: This appendix presents the radionuclide concentrations in drinking water and associated lifetime risks for a 15 year old who consumes the indicated radionuclides in drinking water at that age.

Appendix 8 – Adult: This appendix presents the radionuclide concentrations in drinking water and associated lifetime risks for an adult who consumes the indicated radionuclides in drinking water over the specified time periods. The FGR 13 CD provides DCFs for adults and does not make a distinction among adults of different ages because the actual age when the adult ingests the drinking water has little effect on the trigger level or lifetime risk, until he or she is quite old; then the trigger levels decline due to declining DCFs because the time period over which the

dose is delivered begins to decrease. Risks declines because of the latency period associated with cancer induction, which can extend beyond normal life expectancy.

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APPENDIX 1: ALL AGE GROUPS

Most Restrictive (i.e., Lowest)

Drinking Water Concentration (pCi/L) for Specified Dose (mrem) Over Specified Time

	30 days	4	10	15	25	100	250	300	400	500
Sr-90	5.07E+02	1.27E+03	1.90E+03	3.17E+03	1.27E+04	3.17E+04	3.81E+04	5.07E+04	6.34E+04	
Y-90	6.03E+03	1.51E+04	2.26E+04	3.77E+04	1.51E+05	3.77E+05	4.52E+05	6.03E+05	7.53E+05	
Cs-137	2.33E+03	5.83E+03	8.74E+03	1.46E+04	5.83E+04	1.46E+05	1.75E+05	2.33E+05	2.91E+05	
I-131	6.39E+02	1.60E+03	2.40E+03	4.00E+03	1.60E+04	4.00E+04	4.79E+04	6.39E+04	7.99E+04	
Ir-192	1.41E+04	3.52E+04	5.28E+04	8.80E+04	3.52E+05	8.80E+05	1.06E+06	1.41E+06	1.76E+06	
Po-210	3.56E+01	8.90E+01	1.33E+02	2.22E+02	8.90E+02	2.22E+03	2.67E+03	3.56E+03	4.45E+03	
Co-60	3.47E+03	8.69E+03	1.30E+04	2.17E+04	8.69E+04	2.17E+05	2.61E+05	3.47E+05	4.34E+05	
	60 days	4	10	15	25	100	250	300	400	500
Sr-90	2.54E+02	6.34E+02	9.52E+02	1.59E+03	6.34E+03	1.59E+04	1.90E+04	2.54E+04	3.17E+04	
Y-90	3.01E+03	7.53E+03	1.13E+04	1.88E+04	7.53E+04	1.88E+05	2.26E+05	3.01E+05	3.77E+05	
Cs-137	1.17E+03	2.91E+03	4.37E+03	7.28E+03	2.91E+04	7.28E+04	8.74E+04	1.17E+05	1.46E+05	
I-131	3.20E+02	7.99E+02	1.20E+03	2.00E+03	7.99E+03	2.00E+04	2.40E+04	3.20E+04	4.00E+04	
Ir-192	7.04E+03	1.76E+04	2.64E+04	4.40E+04	1.76E+05	4.40E+05	5.28E+05	7.04E+05	8.80E+05	
Po-210	1.78E+01	4.45E+01	6.67E+01	1.11E+02	4.45E+02	1.11E+03	1.33E+03	1.78E+03	2.22E+03	
Co-60	1.74E+03	4.34E+03	6.51E+03	1.09E+04	4.34E+04	1.09E+05	1.30E+05	1.74E+05	2.17E+05	
	90 days	4	10	15	25	100	250	300	400	500
Sr-90	1.69E+02	4.23E+02	6.34E+02	1.06E+03	4.23E+03	1.06E+04	1.27E+04	1.69E+04	2.11E+04	
Y-90	2.01E+03	5.02E+03	7.53E+03	1.26E+04	5.02E+04	1.26E+05	1.51E+05	2.01E+05	2.51E+05	
Cs-137	7.77E+02	1.94E+03	2.91E+03	4.86E+03	1.94E+04	4.86E+04	5.83E+04	7.77E+04	9.71E+04	
I-131	2.13E+02	5.33E+02	7.99E+02	1.33E+03	5.33E+03	1.33E+04	1.60E+04	2.13E+04	2.66E+04	
Ir-192	4.69E+03	1.17E+04	1.76E+04	2.93E+04	1.17E+05	2.93E+05	3.52E+05	4.69E+05	5.87E+05	
Po-210	1.19E+01	2.97E+01	4.45E+01	7.42E+01	2.97E+02	7.42E+02	8.90E+02	1.19E+03	1.48E+03	
Co-60	1.16E+03	2.90E+03	4.34E+03	7.24E+03	2.90E+04	7.24E+04	8.69E+04	1.16E+05	1.45E+05	
	365 days	4	10	15	25	100	250	300	400	500
Sr-90	4.17E+01	1.04E+02	1.56E+02	2.61E+02	1.04E+03	2.61E+03	3.13E+03	4.17E+03	5.21E+03	
Y-90	4.95E+02	1.24E+03	1.86E+03	3.10E+03	1.24E+04	3.10E+04	3.72E+04	4.95E+04	6.19E+04	
Cs-137	1.92E+02	4.79E+02	7.18E+02	1.20E+03	4.79E+03	1.20E+04	1.44E+04	1.92E+04	2.39E+04	
I-131	5.25E+01	1.31E+02	1.97E+02	3.28E+02	1.31E+03	3.28E+03	3.94E+03	5.25E+03	6.57E+03	
Ir-192	1.16E+03	2.89E+03	4.34E+03	7.23E+03	2.89E+04	7.23E+04	8.68E+04	1.16E+05	1.45E+05	
Po-210	2.93E+00	7.31E+00	1.10E+01	1.83E+01	7.31E+01	1.83E+02	2.19E+02	2.93E+02	3.66E+02	
Co-60	2.86E+02	7.14E+02	1.07E+03	1.78E+03	7.14E+03	1.78E+04	2.14E+04	2.86E+04	3.57E+04	

Most Restrictive (i.e., Lowest)
Drinking Water Risk for Specified Dose (mrem) Over Specified Time

		4	10	15	25	100	250	300	400	500
30	days									
Sr-90		1.59E-06	3.97E-06	5.96E-06	9.93E-06	3.97E-05	9.93E-05	1.19E-04	1.59E-04	1.99E-04
Y-90		1.68E-06	4.20E-06	6.30E-06	1.05E-05	4.20E-05	1.05E-04	1.26E-04	1.68E-04	2.10E-04
Cs-137		1.81E-06	4.54E-06	6.81E-06	1.13E-05	4.54E-05	1.13E-04	1.36E-04	1.81E-04	2.27E-04
I-131		8.40E-07	2.10E-06	3.15E-06	5.25E-06	2.10E-05	5.25E-05	6.30E-05	8.40E-05	1.05E-04
Ir-192		1.56E-06	3.90E-06	5.85E-06	9.74E-06	3.90E-05	9.74E-05	1.17E-04	1.56E-04	1.95E-04
Po-210		1.10E-06	2.75E-06	4.12E-06	6.87E-06	2.75E-05	6.87E-05	8.24E-05	1.10E-04	1.37E-04
Co-60		1.56E-06	3.89E-06	5.83E-06	9.72E-06	3.89E-05	9.72E-05	1.17E-04	1.56E-04	1.94E-04
60	days									
Sr-90		1.59E-06	3.97E-06	5.96E-06	9.93E-06	3.97E-05	9.93E-05	1.19E-04	1.59E-04	1.99E-04
Y-90		1.68E-06	4.20E-06	6.30E-06	1.05E-05	4.20E-05	1.05E-04	1.26E-04	1.68E-04	2.10E-04
Cs-137		1.81E-06	4.54E-06	6.81E-06	1.13E-05	4.54E-05	1.13E-04	1.36E-04	1.81E-04	2.27E-04
I-131		8.40E-07	2.10E-06	3.15E-06	5.25E-06	2.10E-05	5.25E-05	6.30E-05	8.40E-05	1.05E-04
Ir-192		1.56E-06	3.90E-06	5.85E-06	9.74E-06	3.90E-05	9.74E-05	1.17E-04	1.56E-04	1.95E-04
Po-210		1.10E-06	2.75E-06	4.12E-06	6.87E-06	2.75E-05	6.87E-05	8.24E-05	1.10E-04	1.37E-04
Co-60		1.56E-06	3.89E-06	5.83E-06	9.72E-06	3.89E-05	9.72E-05	1.17E-04	1.56E-04	1.94E-04
90	days									
Sr-90		1.59E-06	3.97E-06	5.96E-06	9.93E-06	3.97E-05	9.93E-05	1.19E-04	1.59E-04	1.99E-04
Y-90		1.68E-06	4.20E-06	6.30E-06	1.05E-05	4.20E-05	1.05E-04	1.26E-04	1.68E-04	2.10E-04
Cs-137		1.81E-06	4.54E-06	6.81E-06	1.13E-05	4.54E-05	1.13E-04	1.36E-04	1.81E-04	2.27E-04
I-131		8.40E-07	2.10E-06	3.15E-06	5.25E-06	2.10E-05	5.25E-05	6.30E-05	8.40E-05	1.05E-04
Ir-192		1.56E-06	3.90E-06	5.85E-06	9.74E-06	3.90E-05	9.74E-05	1.17E-04	1.56E-04	1.95E-04
Po-210		1.10E-06	2.75E-06	4.12E-06	6.87E-06	2.75E-05	6.87E-05	8.24E-05	1.10E-04	1.37E-04
Co-60		1.56E-06	3.89E-06	5.83E-06	9.72E-06	3.89E-05	9.72E-05	1.17E-04	1.56E-04	1.94E-04
365	days									
Sr-90		1.59E-06	3.97E-06	5.96E-06	9.93E-06	3.97E-05	9.93E-05	1.19E-04	1.59E-04	1.99E-04
Y-90		1.68E-06	4.20E-06	6.30E-06	1.05E-05	4.20E-05	1.05E-04	1.26E-04	1.68E-04	2.10E-04
Cs-137		1.81E-06	4.54E-06	6.81E-06	1.13E-05	4.54E-05	1.13E-04	1.36E-04	1.81E-04	2.27E-04
I-131		8.40E-07	2.10E-06	3.15E-06	5.25E-06	2.10E-05	5.25E-05	6.30E-05	8.40E-05	1.05E-04
Ir-192		1.56E-06	3.90E-06	5.85E-06	9.74E-06	3.90E-05	9.74E-05	1.17E-04	1.56E-04	1.95E-04
Po-210		1.10E-06	2.75E-06	4.12E-06	6.87E-06	2.75E-05	6.87E-05	8.24E-05	1.10E-04	1.37E-04
Co-60		1.56E-06	3.89E-06	5.83E-06	9.72E-06	3.89E-05	9.72E-05	1.17E-04	1.56E-04	1.94E-04

Age Group With the Most Restrictive Drinking Water Concentration

APPENDIX 2: DEVELOPING EMBRYO AND FETUS*

Drinking Water Concentration (pCi/L) for Specified Dose (mrem) Over Specified Time

	30 days	4	10	15	25	100	250	300	400	500
Sr-90	1.57E+03	3.93E+03	5.89E+03	9.82E+03	3.93E+04	9.82E+04	1.18E+05	1.57E+05	1.96E+05	
Y-90*										
Cs-137	8.46E+03	2.12E+04	3.17E+04	5.29E+04	2.12E+05	5.29E+05	6.35E+05	8.46E+05	1.06E+06	
I-131	2.10E+03	5.24E+03	7.86E+03	1.31E+04	5.24E+04	1.31E+05	1.57E+05	2.10E+05	2.62E+05	
Ir-192*										
Po-210	4.00E+02	1.00E+03	1.50E+03	2.50E+03	1.00E+04	2.50E+04	3.00E+04	4.00E+04	5.00E+04	
Co-60	2.93E+04	7.33E+04	1.10E+05	1.83E+05	7.33E+05	1.83E+06	2.20E+06	2.93E+06	3.67E+06	
	60 days	4	10	15	25	100	250	300	400	500
Sr-90	7.86E+02	1.96E+03	2.95E+03	4.91E+03	1.96E+04	4.91E+04	5.89E+04	7.86E+04	9.82E+04	
Y-90*										
Cs-137	4.23E+03	1.06E+04	1.59E+04	2.64E+04	1.06E+05	2.64E+05	3.17E+05	4.23E+05	5.29E+05	
I-131	1.05E+03	2.62E+03	3.93E+03	6.55E+03	2.62E+04	6.55E+04	7.86E+04	1.05E+05	1.31E+05	
Ir-192*										
Po-210	2.00E+02	5.00E+02	7.50E+02	1.25E+03	5.00E+03	1.25E+04	1.50E+04	2.00E+04	2.50E+04	
Co-60	1.47E+04	3.67E+04	5.50E+04	9.17E+04	3.67E+05	9.17E+05	1.10E+06	1.47E+06	1.83E+06	
	90 days	4	10	15	25	100	250	300	400	500
Sr-90	5.24E+02	1.31E+03	1.96E+03	3.27E+03	1.31E+04	3.27E+04	3.93E+04	5.24E+04	6.55E+04	
Y-90*										
Cs-137	2.82E+03	7.05E+03	1.06E+04	1.76E+04	7.05E+04	1.76E+05	2.12E+05	2.82E+05	3.53E+05	
I-131	6.98E+02	1.75E+03	2.62E+03	4.37E+03	1.75E+04	4.37E+04	5.24E+04	6.98E+04	8.73E+04	
Ir-192*										
Po-210	1.33E+02	3.33E+02	5.00E+02	8.33E+02	3.33E+03	8.33E+03	1.00E+04	1.33E+04	1.67E+04	
Co-60	9.78E+03	2.44E+04	3.67E+04	6.11E+04	2.44E+05	6.11E+05	7.33E+05	9.78E+05	1.22E+06	
	270 days	4	10	15	25	100	250	300	400	500
Sr-90	1.75E+02	4.37E+02	6.55E+02	1.09E+03	4.37E+03	1.09E+04	1.31E+04	1.75E+04	2.18E+04	
Y-90*										
Cs-137	9.40E+02	2.35E+03	3.53E+03	5.88E+03	2.35E+04	5.88E+04	7.05E+04	9.40E+04	1.18E+05	
I-131	2.33E+02	5.82E+02	8.73E+02	1.46E+03	5.82E+03	1.46E+04	1.75E+04	2.33E+04	2.91E+04	
Ir-192*										
Po-210	4.44E+01	1.11E+02	1.67E+02	2.78E+02	1.11E+03	2.78E+03	3.33E+03	4.44E+03	5.56E+03	
Co-60	3.26E+03	8.15E+03	1.22E+04	2.04E+04	8.15E+04	2.04E+05	2.44E+05	3.26E+05	4.07E+05	

* DCFs for Y-90 and Ir-192 for the developing fetus have not been developed. Hence these rows are left blank. This does not mean there are zero doses. We are not able to assign doses at this time.

Risks Associated with Exposure in Utero

Risk conversion factors are not available for in utero exposure; therefore lifetime risks cannot be quantified.

Though we suspect that there might be some level of health risk to the developing fetus due to exposures resulting from the ingestion of contaminated water by the mother during gestation, Table 1-1 NCRP Report No. 17 titled, *Preconception and Prenatal Radiation Exposure: Health Effects and Protective Guidance* (2013) states that minimal non-stochastic health effects are anticipated at acute doses of low LET radiation below 15 rem during the most radiosensitive gestation time periods. Table 1-1 also states that “The lifetime risk of oncogenic effects following in utero irradiation appears to be lower than that following irradiation during childhood.” Table 1-1 also states that “There is no data available that informs on which stages of pregnancy may be the most vulnerable to the oncogenic effects of radiation.”

On this basis, we assume that exposures to other age groups are limiting or at least as radiosensitive with respect to health risk for chronic low levels of low LET radiation.

APPENDIX 3: INFANT

Drinking Water Concentration (pCi/L) for Specified Dose (mrem) Over Specified Time

	30 days	4	10	15	25	100	250	300	400	500
Sr-90	8.31E+02	2.08E+03	3.12E+03	5.19E+03	2.08E+04	5.19E+04	6.23E+04	8.31E+04	1.04E+05	
Y-90	6.03E+03	1.51E+04	2.26E+04	3.77E+04	1.51E+05	3.77E+05	4.52E+05	6.03E+05	7.53E+05	
Cs-137	8.94E+03	2.24E+04	3.35E+04	5.59E+04	2.24E+05	5.59E+05	6.71E+05	8.94E+05	1.12E+06	
I-131	1.03E+03	2.56E+03	3.85E+03	6.41E+03	2.56E+04	6.41E+04	7.69E+04	1.03E+05	1.28E+05	
Ir-192	1.41E+04	3.52E+04	5.28E+04	8.80E+04	3.52E+05	8.80E+05	1.06E+06	1.41E+06	1.76E+06	
Po-210	3.56E+01	8.90E+01	1.33E+02	2.22E+02	8.90E+02	2.22E+03	2.67E+03	3.56E+03	4.45E+03	
Co-60	3.47E+03	8.69E+03	1.30E+04	2.17E+04	8.69E+04	2.17E+05	2.61E+05	3.47E+05	4.34E+05	
	60 days	4	10	15	25	100	250	300	400	500
Sr-90	4.16E+02	1.04E+03	1.56E+03	2.60E+03	1.04E+04	2.60E+04	3.12E+04	4.16E+04	5.19E+04	
Y-90	3.01E+03	7.53E+03	1.13E+04	1.88E+04	7.53E+04	1.88E+05	2.26E+05	3.01E+05	3.77E+05	
Cs-137	4.47E+03	1.12E+04	1.68E+04	2.79E+04	1.12E+05	2.79E+05	3.35E+05	4.47E+05	5.59E+05	
I-131	5.13E+02	1.28E+03	1.92E+03	3.20E+03	1.28E+04	3.20E+04	3.85E+04	5.13E+04	6.41E+04	
Ir-192	7.04E+03	1.76E+04	2.64E+04	4.40E+04	1.76E+05	4.40E+05	5.28E+05	7.04E+05	8.80E+05	
Po-210	1.78E+01	4.45E+01	6.67E+01	1.11E+02	4.45E+02	1.11E+03	1.33E+03	1.78E+03	2.22E+03	
Co-60	1.74E+03	4.34E+03	6.51E+03	1.09E+04	4.34E+04	1.09E+05	1.30E+05	1.74E+05	2.17E+05	
	90 days	4	10	15	25	100	250	300	400	500
Sr-90	2.77E+02	6.93E+02	1.04E+03	1.73E+03	6.93E+03	1.73E+04	2.08E+04	2.77E+04	3.46E+04	
Y-90	2.01E+03	5.02E+03	7.53E+03	1.26E+04	5.02E+04	1.26E+05	1.51E+05	2.01E+05	2.51E+05	
Cs-137	2.98E+03	7.45E+03	1.12E+04	1.86E+04	7.45E+04	1.86E+05	2.24E+05	2.98E+05	3.73E+05	
I-131	3.42E+02	8.54E+02	1.28E+03	2.14E+03	8.54E+03	2.14E+04	2.56E+04	3.42E+04	4.27E+04	
Ir-192	4.69E+03	1.17E+04	1.76E+04	2.93E+04	1.17E+05	2.93E+05	3.52E+05	4.69E+05	5.87E+05	
Po-210	1.19E+01	2.97E+01	4.45E+01	7.42E+01	2.97E+02	7.42E+02	8.90E+02	1.19E+03	1.48E+03	
Co-60	1.16E+03	2.90E+03	4.34E+03	7.24E+03	2.90E+04	7.24E+04	8.69E+04	1.16E+05	1.45E+05	
	365 days	4	10	15	25	100	250	300	400	500
Sr-90	6.83E+01	1.71E+02	2.56E+02	4.27E+02	1.71E+03	4.27E+03	5.12E+03	6.83E+03	8.54E+03	
Y-90	4.95E+02	1.24E+03	1.86E+03	3.10E+03	1.24E+04	3.10E+04	3.72E+04	4.95E+04	6.19E+04	
Cs-137	7.35E+02	1.84E+03	2.76E+03	4.59E+03	1.84E+04	4.59E+04	5.51E+04	7.35E+04	9.19E+04	
I-131	8.43E+01	2.11E+02	3.16E+02	5.27E+02	2.11E+03	5.27E+03	6.32E+03	8.43E+03	1.05E+04	
Ir-192	1.16E+03	2.89E+03	4.34E+03	7.23E+03	2.89E+04	7.23E+04	8.68E+04	1.16E+05	1.45E+05	
Po-210	2.93E+00	7.31E+00	1.10E+01	1.83E+01	7.31E+01	1.83E+02	2.19E+02	2.93E+02	3.66E+02	
Co-60	2.86E+02	7.14E+02	1.07E+03	1.78E+03	7.14E+03	1.78E+04	2.14E+04	2.86E+04	3.57E+04	

Drinking Water Risk for Specified Dose (mrem) Over Specified Time

		30 days	4	10	15	25	100	250	300	400	500
Sr-90		2.38E-06	5.95E-06	8.92E-06	1.49E-05	5.95E-05	1.49E-04	1.78E-04	2.38E-04	2.97E-04	
Y-90		1.42E-05	3.55E-05	5.32E-05	8.87E-05	3.55E-04	8.87E-04	1.06E-03	1.42E-03	1.77E-03	
Cs-137		6.45E-06	1.61E-05	2.42E-05	4.03E-05	1.61E-04	4.03E-04	4.83E-04	6.45E-04	8.06E-04	
I-131		4.67E-06	1.17E-05	1.75E-05	2.92E-05	1.17E-04	2.92E-04	3.51E-04	4.67E-04	5.84E-04	
Ir-192		1.23E-05	3.07E-05	4.61E-05	7.69E-05	3.07E-04	7.69E-04	9.22E-04	1.23E-03	1.54E-03	
Po-210		1.34E-06	3.34E-06	5.01E-06	8.35E-06	3.34E-05	8.35E-05	1.00E-04	1.34E-04	1.67E-04	
Co-60		5.54E-06	1.38E-05	2.08E-05	3.46E-05	1.38E-04	3.46E-04	4.15E-04	5.54E-04	6.92E-04	
		60 days	4	10	15	25	100	250	300	400	500
Sr-90		2.38E-06	5.95E-06	8.92E-06	1.49E-05	5.95E-05	1.49E-04	1.78E-04	2.38E-04	2.97E-04	
Y-90		1.42E-05	3.55E-05	5.32E-05	8.87E-05	3.55E-04	8.87E-04	1.06E-03	1.42E-03	1.77E-03	
Cs-137		6.45E-06	1.61E-05	2.42E-05	4.03E-05	1.61E-04	4.03E-04	4.83E-04	6.45E-04	8.06E-04	
I-131		4.67E-06	1.17E-05	1.75E-05	2.92E-05	1.17E-04	2.92E-04	3.51E-04	4.67E-04	5.84E-04	
Ir-192		1.23E-05	3.07E-05	4.61E-05	7.69E-05	3.07E-04	7.69E-04	9.22E-04	1.23E-03	1.54E-03	
Po-210		1.34E-06	3.34E-06	5.01E-06	8.35E-06	3.34E-05	8.35E-05	1.00E-04	1.34E-04	1.67E-04	
Co-60		5.54E-06	1.38E-05	2.08E-05	3.46E-05	1.38E-04	3.46E-04	4.15E-04	5.54E-04	6.92E-04	
		90 days	4	10	15	25	100	250	300	400	500
Sr-90		2.38E-06	5.95E-06	8.92E-06	1.49E-05	5.95E-05	1.49E-04	1.78E-04	2.38E-04	2.97E-04	
Y-90		1.42E-05	3.55E-05	5.32E-05	8.87E-05	3.55E-04	8.87E-04	1.06E-03	1.42E-03	1.77E-03	
Cs-137		6.45E-06	1.61E-05	2.42E-05	4.03E-05	1.61E-04	4.03E-04	4.83E-04	6.45E-04	8.06E-04	
I-131		4.67E-06	1.17E-05	1.75E-05	2.92E-05	1.17E-04	2.92E-04	3.51E-04	4.67E-04	5.84E-04	
Ir-192		1.23E-05	3.07E-05	4.61E-05	7.69E-05	3.07E-04	7.69E-04	9.22E-04	1.23E-03	1.54E-03	
Po-210		1.34E-06	3.34E-06	5.01E-06	8.35E-06	3.34E-05	8.35E-05	1.00E-04	1.34E-04	1.67E-04	
Co-60		5.54E-06	1.38E-05	2.08E-05	3.46E-05	1.38E-04	3.46E-04	4.15E-04	5.54E-04	6.92E-04	
		365 days	4	10	15	25	100	250	300	400	500
Sr-90		2.38E-06	5.95E-06	8.92E-06	1.49E-05	5.95E-05	1.49E-04	1.78E-04	2.38E-04	2.97E-04	
Y-90		1.42E-05	3.55E-05	5.32E-05	8.87E-05	3.55E-04	8.87E-04	1.06E-03	1.42E-03	1.77E-03	
Cs-137		6.45E-06	1.61E-05	2.42E-05	4.03E-05	1.61E-04	4.03E-04	4.83E-04	6.45E-04	8.06E-04	
I-131		4.67E-06	1.17E-05	1.75E-05	2.92E-05	1.17E-04	2.92E-04	3.51E-04	4.67E-04	5.84E-04	
Ir-192		1.23E-05	3.07E-05	4.61E-05	7.69E-05	3.07E-04	7.69E-04	9.22E-04	1.23E-03	1.54E-03	
Po-210		1.34E-06	3.34E-06	5.01E-06	8.35E-06	3.34E-05	8.35E-05	1.00E-04	1.34E-04	1.67E-04	
Co-60		5.54E-06	1.38E-05	2.08E-05	3.46E-05	1.38E-04	3.46E-04	4.15E-04	5.54E-04	6.92E-04	

APPENDIX 4: 1 YEAR OLD

Drinking Water Concentration (pCi/L) for Specified Dose (mrem) Over Specified Time

	30 days	4	10	15	25	100	250	300	400	500
Sr-90	2.23E+03	5.58E+03	8.37E+03	1.39E+04	5.58E+04	1.39E+05	1.67E+05	2.23E+05	2.79E+05	
Y-90	8.08E+03	2.02E+04	3.03E+04	5.05E+04	2.02E+05	5.05E+05	6.06E+05	8.08E+05	1.01E+06	
Cs-137	1.30E+04	3.26E+04	4.89E+04	8.14E+04	3.26E+05	8.14E+05	9.77E+05	1.30E+06	1.63E+06	
I-131	9.03E+02	2.26E+03	3.39E+03	5.64E+03	2.26E+04	5.64E+04	6.77E+04	9.03E+04	1.13E+05	
Ir-192	1.85E+04	4.62E+04	6.93E+04	1.16E+05	4.62E+05	1.16E+06	1.39E+06	1.85E+06	2.31E+06	
Po-210	9.03E+01	2.26E+02	3.39E+02	5.64E+02	2.26E+03	5.64E+03	6.77E+03	9.03E+03	1.13E+04	
Co-60	6.03E+03	1.51E+04	2.26E+04	3.77E+04	1.51E+05	3.77E+05	4.52E+05	6.03E+05	7.54E+05	
	60 days	4	10	15	25	100	250	300	400	500
Sr-90	1.12E+03	2.79E+03	4.18E+03	6.97E+03	2.79E+04	6.97E+04	8.37E+04	1.12E+05	1.39E+05	
Y-90	4.04E+03	1.01E+04	1.51E+04	2.52E+04	1.01E+05	2.52E+05	3.03E+05	4.04E+05	5.05E+05	
Cs-137	6.52E+03	1.63E+04	2.44E+04	4.07E+04	1.63E+05	4.07E+05	4.89E+05	6.52E+05	8.14E+05	
I-131	4.51E+02	1.13E+03	1.69E+03	2.82E+03	1.13E+04	2.82E+04	3.39E+04	4.51E+04	5.64E+04	
Ir-192	9.24E+03	2.31E+04	3.47E+04	5.78E+04	2.31E+05	5.78E+05	6.93E+05	9.24E+05	1.16E+06	
Po-210	4.51E+01	1.13E+02	1.69E+02	2.82E+02	1.13E+03	2.82E+03	3.39E+03	4.51E+03	5.64E+03	
Co-60	3.01E+03	7.54E+03	1.13E+04	1.88E+04	7.54E+04	1.88E+05	2.26E+05	3.01E+05	3.77E+05	
	90 days	4	10	15	25	100	250	300	400	500
Sr-90	7.44E+02	1.86E+03	2.79E+03	4.65E+03	1.86E+04	4.65E+04	5.58E+04	7.44E+04	9.30E+04	
Y-90	2.69E+03	6.73E+03	1.01E+04	1.68E+04	6.73E+04	1.68E+05	2.02E+05	2.69E+05	3.37E+05	
Cs-137	4.34E+03	1.09E+04	1.63E+04	2.71E+04	1.09E+05	2.71E+05	3.26E+05	4.34E+05	5.43E+05	
I-131	3.01E+02	7.52E+02	1.13E+03	1.88E+03	7.52E+03	1.88E+04	2.26E+04	3.01E+04	3.76E+04	
Ir-192	6.16E+03	1.54E+04	2.31E+04	3.85E+04	1.54E+05	3.85E+05	4.62E+05	6.16E+05	7.70E+05	
Po-210	3.01E+01	7.52E+01	1.13E+02	1.88E+02	7.52E+02	1.88E+03	2.26E+03	3.01E+03	3.76E+03	
Co-60	2.01E+03	5.02E+03	7.54E+03	1.26E+04	5.02E+04	1.26E+05	1.51E+05	2.01E+05	2.51E+05	
	365 days	4	10	15	25	100	250	300	400	500
Sr-90	1.83E+02	4.59E+02	6.88E+02	1.15E+03	4.59E+03	1.15E+04	1.38E+04	1.83E+04	2.29E+04	
Y-90	6.64E+02	1.66E+03	2.49E+03	4.15E+03	1.66E+04	4.15E+04	4.98E+04	6.64E+04	8.30E+04	
Cs-137	1.07E+03	2.68E+03	4.02E+03	6.69E+03	2.68E+04	6.69E+04	8.03E+04	1.07E+05	1.34E+05	
I-131	7.42E+01	1.86E+02	2.78E+02	4.64E+02	1.86E+03	4.64E+03	5.57E+03	7.42E+03	9.28E+03	
Ir-192	1.52E+03	3.80E+03	5.70E+03	9.50E+03	3.80E+04	9.50E+04	1.14E+05	1.52E+05	1.90E+05	
Po-210	7.42E+00	1.86E+01	2.78E+01	4.64E+01	1.86E+02	4.64E+02	5.57E+02	7.42E+02	9.28E+02	
Co-60	4.96E+02	1.24E+03	1.86E+03	3.10E+03	1.24E+04	3.10E+04	3.72E+04	4.96E+04	6.19E+04	

Drinking Water Risk for Specified Dose (mrem) Over Specified Time

		days										
		4	10	15	25	100	250	300	400	500		
Sr-90	4.75E-06	1.19E-05	1.78E-05	2.97E-05	1.19E-04	2.97E-04	3.56E-04	4.75E-04	5.93E-04			
Y-90	1.62E-05	4.04E-05	6.06E-05	1.01E-04	4.04E-04	1.01E-03	1.21E-03	1.62E-03	2.02E-03			
Cs-137	8.03E-06	2.01E-05	3.01E-05	5.02E-05	2.01E-04	5.02E-04	6.02E-04	8.03E-04	1.00E-03			
I-131	4.45E-06	1.11E-05	1.67E-05	2.78E-05	1.11E-04	2.78E-04	3.34E-04	4.45E-04	5.56E-04			
Ir-192	1.39E-05	3.48E-05	5.22E-05	8.70E-05	3.48E-04	8.70E-04	1.04E-03	1.39E-03	1.74E-03			
Po-210	2.13E-06	5.31E-06	7.97E-06	1.33E-05	5.31E-05	1.33E-04	1.59E-04	2.13E-04	2.66E-04			
Co-60	7.79E-06	1.95E-05	2.92E-05	4.87E-05	1.95E-04	4.87E-04	5.84E-04	7.79E-04	9.74E-04			
		60	days	4	10	15	25	100	250	300	400	500
Sr-90	4.75E-06	1.19E-05	1.78E-05	2.97E-05	1.19E-04	2.97E-04	3.56E-04	4.75E-04	5.93E-04			
Y-90	1.62E-05	4.04E-05	6.06E-05	1.01E-04	4.04E-04	1.01E-03	1.21E-03	1.62E-03	2.02E-03			
Cs-137	8.03E-06	2.01E-05	3.01E-05	5.02E-05	2.01E-04	5.02E-04	6.02E-04	8.03E-04	1.00E-03			
I-131	4.45E-06	1.11E-05	1.67E-05	2.78E-05	1.11E-04	2.78E-04	3.34E-04	4.45E-04	5.56E-04			
Ir-192	1.39E-05	3.48E-05	5.22E-05	8.70E-05	3.48E-04	8.70E-04	1.04E-03	1.39E-03	1.74E-03			
Po-210	2.13E-06	5.31E-06	7.97E-06	1.33E-05	5.31E-05	1.33E-04	1.59E-04	2.13E-04	2.66E-04			
Co-60	7.79E-06	1.95E-05	2.92E-05	4.87E-05	1.95E-04	4.87E-04	5.84E-04	7.79E-04	9.74E-04			
		90	days	4	10	15	25	100	250	300	400	500
Sr-90	4.75E-06	1.19E-05	1.78E-05	2.97E-05	1.19E-04	2.97E-04	3.56E-04	4.75E-04	5.93E-04			
Y-90	1.62E-05	4.04E-05	6.06E-05	1.01E-04	4.04E-04	1.01E-03	1.21E-03	1.62E-03	2.02E-03			
Cs-137	8.03E-06	2.01E-05	3.01E-05	5.02E-05	2.01E-04	5.02E-04	6.02E-04	8.03E-04	1.00E-03			
I-131	4.45E-06	1.11E-05	1.67E-05	2.78E-05	1.11E-04	2.78E-04	3.34E-04	4.45E-04	5.56E-04			
Ir-192	1.39E-05	3.48E-05	5.22E-05	8.70E-05	3.48E-04	8.70E-04	1.04E-03	1.39E-03	1.74E-03			
Po-210	2.13E-06	5.31E-06	7.97E-06	1.33E-05	5.31E-05	1.33E-04	1.59E-04	2.13E-04	2.66E-04			
Co-60	7.79E-06	1.95E-05	2.92E-05	4.87E-05	1.95E-04	4.87E-04	5.84E-04	7.79E-04	9.74E-04			
		365	days	4	10	15	25	100	250	300	400	500
Sr-90	4.75E-06	1.19E-05	1.78E-05	2.97E-05	1.19E-04	2.97E-04	3.56E-04	4.75E-04	5.93E-04			
Y-90	1.62E-05	4.04E-05	6.06E-05	1.01E-04	4.04E-04	1.01E-03	1.21E-03	1.62E-03	2.02E-03			
Cs-137	8.03E-06	2.01E-05	3.01E-05	5.02E-05	2.01E-04	5.02E-04	6.02E-04	8.03E-04	1.00E-03			
I-131	4.45E-06	1.11E-05	1.67E-05	2.78E-05	1.11E-04	2.78E-04	3.34E-04	4.45E-04	5.56E-04			
Ir-192	1.39E-05	3.48E-05	5.22E-05	8.70E-05	3.48E-04	8.70E-04	1.04E-03	1.39E-03	1.74E-03			
Po-210	2.13E-06	5.31E-06	7.97E-06	1.33E-05	5.31E-05	1.33E-04	1.59E-04	2.13E-04	2.66E-04			
Co-60	7.79E-06	1.95E-05	2.92E-05	4.87E-05	1.95E-04	4.87E-04	5.84E-04	7.79E-04	9.74E-04			

APPENDIX 5: 5 YEAR OLD

Drinking Water Concentration (pCi/L) for Specified Dose (mrem) Over Specified Time

	30 days	4	10	15	25	100	250	300	400	500
Sr-90	1.42E+03	3.54E+03	5.32E+03	8.86E+03	3.54E+04	8.86E+04	1.06E+05	1.42E+05	1.77E+05	
Y-90	6.67E+03	1.67E+04	2.50E+04	4.17E+04	1.67E+05	4.17E+05	5.00E+05	6.67E+05	8.34E+05	
Cs-137	6.86E+03	1.72E+04	2.57E+04	4.29E+04	1.72E+05	4.29E+05	5.15E+05	6.86E+05	8.58E+05	
I-131	6.39E+02	1.60E+03	2.40E+03	4.00E+03	1.60E+04	4.00E+04	4.79E+04	6.39E+04	7.99E+04	
Ir-192	1.45E+04	3.62E+04	5.43E+04	9.05E+04	3.62E+05	9.05E+05	1.09E+06	1.45E+06	1.81E+06	
Po-210	7.49E+01	1.87E+02	2.81E+02	4.68E+02	1.87E+03	4.68E+03	5.62E+03	7.49E+03	9.36E+03	
Co-60	3.93E+03	9.84E+03	1.48E+04	2.46E+04	9.84E+04	2.46E+05	2.95E+05	3.93E+05	4.92E+05	
	60 days	4	10	15	25	100	250	300	400	500
Sr-90	7.09E+02	1.77E+03	2.66E+03	4.43E+03	1.77E+04	4.43E+04	5.32E+04	7.09E+04	8.86E+04	
Y-90	3.33E+03	8.34E+03	1.25E+04	2.08E+04	8.34E+04	2.08E+05	2.50E+05	3.33E+05	4.17E+05	
Cs-137	3.43E+03	8.58E+03	1.29E+04	2.14E+04	8.58E+04	2.14E+05	2.57E+05	3.43E+05	4.29E+05	
I-131	3.20E+02	7.99E+02	1.20E+03	2.00E+03	7.99E+03	2.00E+04	2.40E+04	3.20E+04	4.00E+04	
Ir-192	7.24E+03	1.81E+04	2.72E+04	4.53E+04	1.81E+05	4.53E+05	5.43E+05	7.24E+05	9.05E+05	
Po-210	3.74E+01	9.36E+01	1.40E+02	2.34E+02	9.36E+02	2.34E+03	2.81E+03	3.74E+03	4.68E+03	
Co-60	1.97E+03	4.92E+03	7.38E+03	1.23E+04	4.92E+04	1.23E+05	1.48E+05	1.97E+05	2.46E+05	
	90 days	4	10	15	25	100	250	300	400	500
Sr-90	4.73E+02	1.18E+03	1.77E+03	2.95E+03	1.18E+04	2.95E+04	3.54E+04	4.73E+04	5.91E+04	
Y-90	2.22E+03	5.56E+03	8.34E+03	1.39E+04	5.56E+04	1.39E+05	1.67E+05	2.22E+05	2.78E+05	
Cs-137	2.29E+03	5.72E+03	8.58E+03	1.43E+04	5.72E+04	1.43E+05	1.72E+05	2.29E+05	2.86E+05	
I-131	2.13E+02	5.33E+02	7.99E+02	1.33E+03	5.33E+03	1.33E+04	1.60E+04	2.13E+04	2.66E+04	
Ir-192	4.83E+03	1.21E+04	1.81E+04	3.02E+04	1.21E+05	3.02E+05	3.62E+05	4.83E+05	6.04E+05	
Po-210	2.50E+01	6.24E+01	9.36E+01	1.56E+02	6.24E+02	1.56E+03	1.87E+03	2.50E+03	3.12E+03	
Co-60	1.31E+03	3.28E+03	4.92E+03	8.20E+03	3.28E+04	8.20E+04	9.84E+04	1.31E+05	1.64E+05	
	365 days	4	10	15	25	100	250	300	400	500
Sr-90	1.17E+02	2.91E+02	4.37E+02	7.28E+02	2.91E+03	7.28E+03	8.74E+03	1.17E+04	1.46E+04	
Y-90	5.48E+02	1.37E+03	2.06E+03	3.43E+03	1.37E+04	3.43E+04	4.11E+04	5.48E+04	6.85E+04	
Cs-137	5.64E+02	1.41E+03	2.11E+03	3.52E+03	1.41E+04	3.52E+04	4.23E+04	5.64E+04	7.05E+04	
I-131	5.25E+01	1.31E+02	1.97E+02	3.28E+02	1.31E+03	3.28E+03	3.94E+03	5.25E+03	6.57E+03	
Ir-192	1.19E+03	2.98E+03	4.46E+03	7.44E+03	2.98E+04	7.44E+04	8.93E+04	1.19E+05	1.49E+05	
Po-210	6.15E+00	1.54E+01	2.31E+01	3.85E+01	1.54E+02	3.85E+02	4.62E+02	6.15E+02	7.69E+02	
Co-60	3.23E+02	8.08E+02	1.21E+03	2.02E+03	8.08E+03	2.02E+04	2.43E+04	3.23E+04	4.04E+04	

Drinking Water Risk for Specified Dose (mrem) Over Specified Time

		4	10	15	25	100	250	300	400	500
30	days									
Sr-90		4.38E-06	1.09E-05	1.64E-05	2.73E-05	1.09E-04	2.73E-04	3.28E-04	4.38E-04	5.47E-04
Y-90		1.71E-05	4.26E-05	6.39E-05	1.07E-04	4.26E-04	1.07E-03	1.28E-03	1.71E-03	2.13E-03
Cs-137		8.13E-06	2.03E-05	3.05E-05	5.08E-05	2.03E-04	5.08E-04	6.10E-04	8.13E-04	1.02E-03
I-131		4.08E-06	1.02E-05	1.53E-05	2.55E-05	1.02E-04	2.55E-04	3.06E-04	4.08E-04	5.10E-04
Ir-192		1.44E-05	3.59E-05	5.39E-05	8.99E-05	3.59E-04	8.99E-04	1.08E-03	1.44E-03	1.80E-03
Po-210		2.32E-06	5.80E-06	8.70E-06	1.45E-05	5.80E-05	1.45E-04	1.74E-04	2.32E-04	2.90E-04
Co-60		7.81E-06	1.95E-05	2.93E-05	4.88E-05	1.95E-04	4.88E-04	5.86E-04	7.81E-04	9.76E-04
60	days									
Sr-90		4.38E-06	1.09E-05	1.64E-05	2.73E-05	1.09E-04	2.73E-04	3.28E-04	4.38E-04	5.47E-04
Y-90		1.71E-05	4.26E-05	6.39E-05	1.07E-04	4.26E-04	1.07E-03	1.28E-03	1.71E-03	2.13E-03
Cs-137		8.13E-06	2.03E-05	3.05E-05	5.08E-05	2.03E-04	5.08E-04	6.10E-04	8.13E-04	1.02E-03
I-131		4.08E-06	1.02E-05	1.53E-05	2.55E-05	1.02E-04	2.55E-04	3.06E-04	4.08E-04	5.10E-04
Ir-192		1.44E-05	3.59E-05	5.39E-05	8.99E-05	3.59E-04	8.99E-04	1.08E-03	1.44E-03	1.80E-03
Po-210		2.32E-06	5.80E-06	8.70E-06	1.45E-05	5.80E-05	1.45E-04	1.74E-04	2.32E-04	2.90E-04
Co-60		7.81E-06	1.95E-05	2.93E-05	4.88E-05	1.95E-04	4.88E-04	5.86E-04	7.81E-04	9.76E-04
90	days									
Sr-90		4.38E-06	1.09E-05	1.64E-05	2.73E-05	1.09E-04	2.73E-04	3.28E-04	4.38E-04	5.47E-04
Y-90		1.71E-05	4.26E-05	6.39E-05	1.07E-04	4.26E-04	1.07E-03	1.28E-03	1.71E-03	2.13E-03
Cs-137		8.13E-06	2.03E-05	3.05E-05	5.08E-05	2.03E-04	5.08E-04	6.10E-04	8.13E-04	1.02E-03
I-131		4.08E-06	1.02E-05	1.53E-05	2.55E-05	1.02E-04	2.55E-04	3.06E-04	4.08E-04	5.10E-04
Ir-192		1.44E-05	3.59E-05	5.39E-05	8.99E-05	3.59E-04	8.99E-04	1.08E-03	1.44E-03	1.80E-03
Po-210		2.32E-06	5.80E-06	8.70E-06	1.45E-05	5.80E-05	1.45E-04	1.74E-04	2.32E-04	2.90E-04
Co-60		7.81E-06	1.95E-05	2.93E-05	4.88E-05	1.95E-04	4.88E-04	5.86E-04	7.81E-04	9.76E-04
365	days									
Sr-90		4.38E-06	1.09E-05	1.64E-05	2.73E-05	1.09E-04	2.73E-04	3.28E-04	4.38E-04	5.47E-04
Y-90		1.71E-05	4.26E-05	6.39E-05	1.07E-04	4.26E-04	1.07E-03	1.28E-03	1.71E-03	2.13E-03
Cs-137		8.13E-06	2.03E-05	3.05E-05	5.08E-05	2.03E-04	5.08E-04	6.10E-04	8.13E-04	1.02E-03
I-131		4.08E-06	1.02E-05	1.53E-05	2.55E-05	1.02E-04	2.55E-04	3.06E-04	4.08E-04	5.10E-04
Ir-192		1.44E-05	3.59E-05	5.39E-05	8.99E-05	3.59E-04	8.99E-04	1.08E-03	1.44E-03	1.80E-03
Po-210		2.32E-06	5.80E-06	8.70E-06	1.45E-05	5.80E-05	1.45E-04	1.74E-04	2.32E-04	2.90E-04
Co-60		7.81E-06	1.95E-05	2.93E-05	4.88E-05	1.95E-04	4.88E-04	5.86E-04	7.81E-04	9.76E-04

APPENDIX 6: 10 YEAR OLD

Drinking Water Concentration (pCi/L) for Specified Dose (mrem) Over Specified Time

		Drinking Water Concentration (pCi/L) for Specified Dose (mrem) Over Specified Time								
30 days		4	10	15	25	100	250	300	400	500
Sr-90	8.33E+02	2.08E+03	3.12E+03	5.20E+03	2.08E+04	5.20E+04	6.24E+04	8.33E+04	1.04E+05	
Y-90	8.42E+03	2.11E+04	3.16E+04	5.27E+04	2.11E+05	5.27E+05	6.32E+05	8.42E+05	1.05E+06	
Cs-137	4.92E+03	1.23E+04	1.85E+04	3.08E+04	1.23E+05	3.08E+05	3.69E+05	4.92E+05	6.15E+05	
I-131	9.49E+02	2.37E+03	3.56E+03	5.93E+03	2.37E+04	5.93E+04	7.11E+04	9.49E+04	1.19E+05	
Ir-192	1.74E+04	4.36E+04	6.54E+04	1.09E+05	4.36E+05	1.09E+06	1.31E+06	1.74E+06	2.18E+06	
Po-210	9.47E+01	2.37E+02	3.55E+02	5.92E+02	2.37E+03	5.92E+03	7.10E+03	9.47E+03	1.18E+04	
Co-60	4.44E+03	1.11E+04	1.66E+04	2.77E+04	1.11E+05	2.77E+05	3.33E+05	4.44E+05	5.55E+05	
60 days		4	10	15	25	100	250	300	400	500
Sr-90	4.16E+02	1.04E+03	1.56E+03	2.60E+03	1.04E+04	2.60E+04	3.12E+04	4.16E+04	5.20E+04	
Y-90	4.21E+03	1.05E+04	1.58E+04	2.63E+04	1.05E+05	2.63E+05	3.16E+05	4.21E+05	5.27E+05	
Cs-137	2.46E+03	6.15E+03	9.23E+03	1.54E+04	6.15E+04	1.54E+05	1.85E+05	2.46E+05	3.08E+05	
I-131	4.74E+02	1.19E+03	1.78E+03	2.96E+03	1.19E+04	2.96E+04	3.56E+04	4.74E+04	5.93E+04	
Ir-192	8.72E+03	2.18E+04	3.27E+04	5.45E+04	2.18E+05	5.45E+05	6.54E+05	8.72E+05	1.09E+06	
Po-210	4.73E+01	1.18E+02	1.78E+02	2.96E+02	1.18E+03	2.96E+03	3.55E+03	4.73E+03	5.92E+03	
Co-60	2.22E+03	5.55E+03	8.32E+03	1.39E+04	5.55E+04	1.39E+05	1.66E+05	2.22E+05	2.77E+05	
90 days		4	10	15	25	100	250	300	400	500
Sr-90	2.78E+02	6.94E+02	1.04E+03	1.73E+03	6.94E+03	1.73E+04	2.08E+04	2.78E+04	3.47E+04	
Y-90	2.81E+03	7.02E+03	1.05E+04	1.76E+04	7.02E+04	1.76E+05	2.11E+05	2.81E+05	3.51E+05	
Cs-137	1.64E+03	4.10E+03	6.15E+03	1.03E+04	4.10E+04	1.03E+05	1.23E+05	1.64E+05	2.05E+05	
I-131	3.16E+02	7.90E+02	1.19E+03	1.98E+03	7.90E+03	1.98E+04	2.37E+04	3.16E+04	3.95E+04	
Ir-192	5.81E+03	1.45E+04	2.18E+04	3.63E+04	1.45E+05	3.63E+05	4.36E+05	5.81E+05	7.27E+05	
Po-210	3.16E+01	7.89E+01	1.18E+02	1.97E+02	7.89E+02	1.97E+03	2.37E+03	3.16E+03	3.94E+03	
Co-60	1.48E+03	3.70E+03	5.55E+03	9.25E+03	3.70E+04	9.25E+04	1.11E+05	1.48E+05	1.85E+05	
365 days		4	10	15	25	100	250	300	400	500
Sr-90	6.84E+01	1.71E+02	2.57E+02	4.28E+02	1.71E+03	4.28E+03	5.13E+03	6.84E+03	8.55E+03	
Y-90	6.92E+02	1.73E+03	2.60E+03	4.33E+03	1.73E+04	4.33E+04	5.19E+04	6.92E+04	8.66E+04	
Cs-137	4.04E+02	1.01E+03	1.52E+03	2.53E+03	1.01E+04	2.53E+04	3.03E+04	4.04E+04	5.06E+04	
I-131	7.80E+01	1.95E+02	2.92E+02	4.87E+02	1.95E+03	4.87E+03	5.85E+03	7.80E+03	9.75E+03	
Ir-192	1.43E+03	3.58E+03	5.38E+03	8.96E+03	3.58E+04	8.96E+04	1.08E+05	1.43E+05	1.79E+05	
Po-210	7.78E+00	1.95E+01	2.92E+01	4.86E+01	1.95E+02	4.86E+02	5.84E+02	7.78E+02	9.73E+02	
Co-60	3.65E+02	9.12E+02	1.37E+03	2.28E+03	9.12E+03	2.28E+04	2.74E+04	3.65E+04	4.56E+04	

Drinking Water Risk for Specified Dose (mrem) Over Specified Time

		4	10	15	25	100	250	300	400	500
30	days									
Sr-90		2.15E-06	5.38E-06	8.07E-06	1.34E-05	5.38E-05	1.34E-04	1.61E-04	2.15E-04	2.69E-04
Y-90		1.72E-05	4.31E-05	6.46E-05	1.08E-04	4.31E-04	1.08E-03	1.29E-03	1.72E-03	2.15E-03
Cs-137		7.88E-06	1.97E-05	2.96E-05	4.93E-05	1.97E-04	4.93E-04	5.91E-04	7.88E-04	9.85E-04
I-131		3.85E-06	9.62E-06	1.44E-05	2.40E-05	9.62E-05	2.40E-04	2.89E-04	3.85E-04	4.81E-04
Ir-192		1.42E-05	3.54E-05	5.32E-05	8.86E-05	3.54E-04	8.86E-04	1.06E-03	1.42E-03	1.77E-03
Po-210		2.42E-06	6.06E-06	9.09E-06	1.51E-05	6.06E-05	1.51E-04	1.82E-04	2.42E-04	3.03E-04
Co-60		7.71E-06	1.93E-05	2.89E-05	4.82E-05	1.93E-04	4.82E-04	5.79E-04	7.71E-04	9.64E-04
60	days									
Sr-90		2.15E-06	5.38E-06	8.07E-06	1.34E-05	5.38E-05	1.34E-04	1.61E-04	2.15E-04	2.69E-04
Y-90		1.72E-05	4.31E-05	6.46E-05	1.08E-04	4.31E-04	1.08E-03	1.29E-03	1.72E-03	2.15E-03
Cs-137		7.88E-06	1.97E-05	2.96E-05	4.93E-05	1.97E-04	4.93E-04	5.91E-04	7.88E-04	9.85E-04
I-131		3.85E-06	9.62E-06	1.44E-05	2.40E-05	9.62E-05	2.40E-04	2.89E-04	3.85E-04	4.81E-04
Ir-192		1.42E-05	3.54E-05	5.32E-05	8.86E-05	3.54E-04	8.86E-04	1.06E-03	1.42E-03	1.77E-03
Po-210		2.42E-06	6.06E-06	9.09E-06	1.51E-05	6.06E-05	1.51E-04	1.82E-04	2.42E-04	3.03E-04
Co-60		7.71E-06	1.93E-05	2.89E-05	4.82E-05	1.93E-04	4.82E-04	5.79E-04	7.71E-04	9.64E-04
90	days									
Sr-90		2.15E-06	5.38E-06	8.07E-06	1.34E-05	5.38E-05	1.34E-04	1.61E-04	2.15E-04	2.69E-04
Y-90		1.72E-05	4.31E-05	6.46E-05	1.08E-04	4.31E-04	1.08E-03	1.29E-03	1.72E-03	2.15E-03
Cs-137		7.88E-06	1.97E-05	2.96E-05	4.93E-05	1.97E-04	4.93E-04	5.91E-04	7.88E-04	9.85E-04
I-131		3.85E-06	9.62E-06	1.44E-05	2.40E-05	9.62E-05	2.40E-04	2.89E-04	3.85E-04	4.81E-04
Ir-192		1.42E-05	3.54E-05	5.32E-05	8.86E-05	3.54E-04	8.86E-04	1.06E-03	1.42E-03	1.77E-03
Po-210		2.42E-06	6.06E-06	9.09E-06	1.51E-05	6.06E-05	1.51E-04	1.82E-04	2.42E-04	3.03E-04
Co-60		7.71E-06	1.93E-05	2.89E-05	4.82E-05	1.93E-04	4.82E-04	5.79E-04	7.71E-04	9.64E-04
365	days									
Sr-90		2.15E-06	5.38E-06	8.07E-06	1.34E-05	5.38E-05	1.34E-04	1.61E-04	2.15E-04	2.69E-04
Y-90		1.72E-05	4.31E-05	6.46E-05	1.08E-04	4.31E-04	1.08E-03	1.29E-03	1.72E-03	2.15E-03
Cs-137		7.88E-06	1.97E-05	2.96E-05	4.93E-05	1.97E-04	4.93E-04	5.91E-04	7.88E-04	9.85E-04
I-131		3.85E-06	9.62E-06	1.44E-05	2.40E-05	9.62E-05	2.40E-04	2.89E-04	3.85E-04	4.81E-04
Ir-192		1.42E-05	3.54E-05	5.32E-05	8.86E-05	3.54E-04	8.86E-04	1.06E-03	1.42E-03	1.77E-03
Po-210		2.42E-06	6.06E-06	9.09E-06	1.51E-05	6.06E-05	1.51E-04	1.82E-04	2.42E-04	3.03E-04
Co-60		7.71E-06	1.93E-05	2.89E-05	4.82E-05	1.93E-04	4.82E-04	5.79E-04	7.71E-04	9.64E-04

APPENDIX 7: 15 YEAR OLD

Drinking Water Concentration (pCi/L) for Specified Dose (mrem) Over Specified Time

	30 days	4	10	15	25	100	250	300	400	500
Sr-90	5.07E+02	1.27E+03	1.90E+03	3.17E+03	1.27E+04	3.17E+04	3.81E+04	5.07E+04	6.34E+04	
Y-90	1.20E+04	3.00E+04	4.50E+04	7.49E+04	3.00E+05	7.49E+05	8.99E+05	1.20E+06	1.50E+06	
Cs-137	2.99E+03	7.47E+03	1.12E+04	1.87E+04	7.47E+04	1.87E+05	2.24E+05	2.99E+05	3.74E+05	
I-131	1.17E+03	2.93E+03	4.39E+03	7.32E+03	2.93E+04	7.32E+04	8.78E+04	1.17E+05	1.46E+05	
Ir-192	2.34E+04	5.85E+04	8.78E+04	1.46E+05	5.85E+05	1.46E+06	1.76E+06	2.34E+06	2.93E+06	
Po-210	1.26E+02	3.14E+02	4.71E+02	7.84E+02	3.14E+03	7.84E+03	9.41E+03	1.26E+04	1.57E+04	
Co-60	5.04E+03	1.26E+04	1.89E+04	3.15E+04	1.26E+05	3.15E+05	3.78E+05	5.04E+05	6.30E+05	
	60 days	4	10	15	25	100	250	300	400	500
Sr-90	2.54E+02	6.34E+02	9.52E+02	1.59E+03	6.34E+03	1.59E+04	1.90E+04	2.54E+04	3.17E+04	
Y-90	5.99E+03	1.50E+04	2.25E+04	3.75E+04	1.50E+05	3.75E+05	4.50E+05	5.99E+05	7.49E+05	
Cs-137	1.49E+03	3.74E+03	5.60E+03	9.34E+03	3.74E+04	9.34E+04	1.12E+05	1.49E+05	1.87E+05	
I-131	5.85E+02	1.46E+03	2.20E+03	3.66E+03	1.46E+04	3.66E+04	4.39E+04	5.85E+04	7.32E+04	
Ir-192	1.17E+04	2.93E+04	4.39E+04	7.32E+04	2.93E+05	7.32E+05	8.78E+05	1.17E+06	1.46E+06	
Po-210	6.28E+01	1.57E+02	2.35E+02	3.92E+02	1.57E+03	3.92E+03	4.71E+03	6.28E+03	7.84E+03	
Co-60	2.52E+03	6.30E+03	9.46E+03	1.58E+04	6.30E+04	1.58E+05	1.89E+05	2.52E+05	3.15E+05	
	90 days	4	10	15	25	100	250	300	400	500
Sr-90	1.69E+02	4.23E+02	6.34E+02	1.06E+03	4.23E+03	1.06E+04	1.27E+04	1.69E+04	2.11E+04	
Y-90	4.00E+03	9.99E+03	1.50E+04	2.50E+04	9.99E+04	2.50E+05	3.00E+05	4.00E+05	5.00E+05	
Cs-137	9.96E+02	2.49E+03	3.74E+03	6.23E+03	2.49E+04	6.23E+04	7.47E+04	9.96E+04	1.25E+05	
I-131	3.90E+02	9.76E+02	1.46E+03	2.44E+03	9.76E+03	2.44E+04	2.93E+04	3.90E+04	4.88E+04	
Ir-192	7.81E+03	1.95E+04	2.93E+04	4.88E+04	1.95E+05	4.88E+05	5.85E+05	7.81E+05	9.76E+05	
Po-210	4.18E+01	1.05E+02	1.57E+02	2.61E+02	1.05E+03	2.61E+03	3.14E+03	4.18E+03	5.23E+03	
Co-60	1.68E+03	4.20E+03	6.30E+03	1.05E+04	4.20E+04	1.05E+05	1.26E+05	1.68E+05	2.10E+05	
	365 days	4	10	15	25	100	250	300	400	500
Sr-90	4.17E+01	1.04E+02	1.56E+02	2.61E+02	1.04E+03	2.61E+03	3.13E+03	4.17E+03	5.21E+03	
Y-90	9.85E+02	2.46E+03	3.69E+03	6.16E+03	2.46E+04	6.16E+04	7.39E+04	9.85E+04	1.23E+05	
Cs-137	2.46E+02	6.14E+02	9.21E+02	1.53E+03	6.14E+03	1.53E+04	1.84E+04	2.46E+04	3.07E+04	
I-131	9.62E+01	2.41E+02	3.61E+02	6.01E+02	2.41E+03	6.01E+03	7.22E+03	9.62E+03	1.20E+04	
Ir-192	1.92E+03	4.81E+03	7.22E+03	1.20E+04	4.81E+04	1.20E+05	1.44E+05	1.92E+05	2.41E+05	
Po-210	1.03E+01	2.58E+01	3.87E+01	6.45E+01	2.58E+02	6.45E+02	7.74E+02	1.03E+03	1.29E+03	
Co-60	4.14E+02	1.04E+03	1.55E+03	2.59E+03	1.04E+04	2.59E+04	3.11E+04	4.14E+04	5.18E+04	

Drinking Water Risk for Specified Dose (mrem) Over Specified Time

		4	10	15	25	100	250	300	400	500
30	days									
Sr-90		1.70E-06	4.26E-06	6.39E-06	1.06E-05	4.26E-05	1.06E-04	1.28E-04	1.70E-04	2.13E-04
Y-90		1.72E-05	4.31E-05	6.47E-05	1.08E-04	4.31E-04	1.08E-03	1.29E-03	1.72E-03	2.16E-03
Cs-137		7.28E-06	1.82E-05	2.73E-05	4.55E-05	1.82E-04	4.55E-04	5.46E-04	7.28E-04	9.10E-04
I-131		3.46E-06	8.65E-06	1.30E-05	2.16E-05	8.65E-05	2.16E-04	2.60E-04	3.46E-04	4.33E-04
Ir-192		1.39E-05	3.47E-05	5.21E-05	8.68E-05	3.47E-04	8.68E-04	1.04E-03	1.39E-03	1.74E-03
Po-210		2.45E-06	6.11E-06	9.17E-06	1.53E-05	6.11E-05	1.53E-04	1.83E-04	2.45E-04	3.06E-04
Co-60		7.15E-06	1.79E-05	2.68E-05	4.47E-05	1.79E-04	4.47E-04	5.37E-04	7.15E-04	8.94E-04
60	days									
Sr-90		1.70E-06	4.26E-06	6.39E-06	1.06E-05	4.26E-05	1.06E-04	1.28E-04	1.70E-04	2.13E-04
Y-90		1.72E-05	4.31E-05	6.47E-05	1.08E-04	4.31E-04	1.08E-03	1.29E-03	1.72E-03	2.16E-03
Cs-137		7.28E-06	1.82E-05	2.73E-05	4.55E-05	1.82E-04	4.55E-04	5.46E-04	7.28E-04	9.10E-04
I-131		3.46E-06	8.65E-06	1.30E-05	2.16E-05	8.65E-05	2.16E-04	2.60E-04	3.46E-04	4.33E-04
Ir-192		1.39E-05	3.47E-05	5.21E-05	8.68E-05	3.47E-04	8.68E-04	1.04E-03	1.39E-03	1.74E-03
Po-210		2.45E-06	6.11E-06	9.17E-06	1.53E-05	6.11E-05	1.53E-04	1.83E-04	2.45E-04	3.06E-04
Co-60		7.15E-06	1.79E-05	2.68E-05	4.47E-05	1.79E-04	4.47E-04	5.37E-04	7.15E-04	8.94E-04
90	days									
Sr-90		1.70E-06	4.26E-06	6.39E-06	1.06E-05	4.26E-05	1.06E-04	1.28E-04	1.70E-04	2.13E-04
Y-90		1.72E-05	4.31E-05	6.47E-05	1.08E-04	4.31E-04	1.08E-03	1.29E-03	1.72E-03	2.16E-03
Cs-137		7.28E-06	1.82E-05	2.73E-05	4.55E-05	1.82E-04	4.55E-04	5.46E-04	7.28E-04	9.10E-04
I-131		3.46E-06	8.65E-06	1.30E-05	2.16E-05	8.65E-05	2.16E-04	2.60E-04	3.46E-04	4.33E-04
Ir-192		1.39E-05	3.47E-05	5.21E-05	8.68E-05	3.47E-04	8.68E-04	1.04E-03	1.39E-03	1.74E-03
Po-210		2.45E-06	6.11E-06	9.17E-06	1.53E-05	6.11E-05	1.53E-04	1.83E-04	2.45E-04	3.06E-04
Co-60		7.15E-06	1.79E-05	2.68E-05	4.47E-05	1.79E-04	4.47E-04	5.37E-04	7.15E-04	8.94E-04
365	days									
Sr-90		1.70E-06	4.26E-06	6.39E-06	1.06E-05	4.26E-05	1.06E-04	1.28E-04	1.70E-04	2.13E-04
Y-90		1.72E-05	4.31E-05	6.47E-05	1.08E-04	4.31E-04	1.08E-03	1.29E-03	1.72E-03	2.16E-03
Cs-137		7.28E-06	1.82E-05	2.73E-05	4.55E-05	1.82E-04	4.55E-04	5.46E-04	7.28E-04	9.10E-04
I-131		3.46E-06	8.65E-06	1.30E-05	2.16E-05	8.65E-05	2.16E-04	2.60E-04	3.46E-04	4.33E-04
Ir-192		1.39E-05	3.47E-05	5.21E-05	8.68E-05	3.47E-04	8.68E-04	1.04E-03	1.39E-03	1.74E-03
Po-210		2.45E-06	6.11E-06	9.17E-06	1.53E-05	6.11E-05	1.53E-04	1.83E-04	2.45E-04	3.06E-04
Co-60		7.15E-06	1.79E-05	2.68E-05	4.47E-05	1.79E-04	4.47E-04	5.37E-04	7.15E-04	8.94E-04

APPENDIX 8: ADULT

Drinking Water Concentration (pCi/L) for Specified Dose (mrem) Over Specified Time

	30 days	4	10	15	25	100	250	300	400	500
Sr-90	1.14E+03	2.86E+03	4.29E+03	7.15E+03	2.86E+04	7.15E+04	8.58E+04	1.14E+05	1.43E+05	
Y-90	1.18E+04	2.95E+04	4.42E+04	7.36E+04	2.95E+05	7.36E+05	8.84E+05	1.18E+06	1.47E+06	
Cs-137	2.33E+03	5.83E+03	8.74E+03	1.46E+04	5.83E+04	1.46E+05	1.75E+05	2.33E+05	2.91E+05	
I-131	1.45E+03	3.63E+03	5.45E+03	9.09E+03	3.63E+04	9.09E+04	1.09E+05	1.45E+05	1.82E+05	
Ir-192	2.31E+04	5.78E+04	8.68E+04	1.45E+05	5.78E+05	1.45E+06	1.74E+06	2.31E+06	2.89E+06	
Po-210	1.29E+02	3.23E+02	4.85E+02	8.09E+02	3.23E+03	8.09E+03	9.70E+03	1.29E+04	1.62E+04	
Co-60	9.27E+03	2.32E+04	3.48E+04	5.79E+04	2.32E+05	5.79E+05	6.95E+05	9.27E+05	1.16E+06	
	60 days	4	10	15	25	100	250	300	400	500
Sr-90	5.72E+02	1.43E+03	2.15E+03	3.58E+03	1.43E+04	3.58E+04	4.29E+04	5.72E+04	7.15E+04	
Y-90	5.89E+03	1.47E+04	2.21E+04	3.68E+04	1.47E+05	3.68E+05	4.42E+05	5.89E+05	7.36E+05	
Cs-137	1.17E+03	2.91E+03	4.37E+03	7.28E+03	2.91E+04	7.28E+04	8.74E+04	1.17E+05	1.46E+05	
I-131	7.27E+02	1.82E+03	2.73E+03	4.54E+03	1.82E+04	4.54E+04	5.45E+04	7.27E+04	9.09E+04	
Ir-192	1.16E+04	2.89E+04	4.34E+04	7.23E+04	2.89E+05	7.23E+05	8.68E+05	1.16E+06	1.45E+06	
Po-210	6.47E+01	1.62E+02	2.43E+02	4.04E+02	1.62E+03	4.04E+03	4.85E+03	6.47E+03	8.09E+03	
Co-60	4.63E+03	1.16E+04	1.74E+04	2.90E+04	1.16E+05	2.90E+05	3.48E+05	4.63E+05	5.79E+05	
	90 days	4	10	15	25	100	250	300	400	500
Sr-90	3.81E+02	9.53E+02	1.43E+03	2.38E+03	9.53E+03	2.38E+04	2.86E+04	3.81E+04	4.77E+04	
Y-90	3.93E+03	9.82E+03	1.47E+04	2.45E+04	9.82E+04	2.45E+05	2.95E+05	3.93E+05	4.91E+05	
Cs-137	7.77E+02	1.94E+03	2.91E+03	4.86E+03	1.94E+04	4.86E+04	5.83E+04	7.77E+04	9.71E+04	
I-131	4.85E+02	1.21E+03	1.82E+03	3.03E+03	1.21E+04	3.03E+04	3.63E+04	4.85E+04	6.06E+04	
Ir-192	7.71E+03	1.93E+04	2.89E+04	4.82E+04	1.93E+05	4.82E+05	5.78E+05	7.71E+05	9.64E+05	
Po-210	4.31E+01	1.08E+02	1.62E+02	2.70E+02	1.08E+03	2.70E+03	3.23E+03	4.31E+03	5.39E+03	
Co-60	3.09E+03	7.72E+03	1.16E+04	1.93E+04	7.72E+04	1.93E+05	2.32E+05	3.09E+05	3.86E+05	
	365 days	4	10	15	25	100	250	300	400	500
Sr-90	9.40E+01	2.35E+02	3.53E+02	5.88E+02	2.35E+03	5.88E+03	7.05E+03	9.40E+03	1.18E+04	
Y-90	9.68E+02	2.42E+03	3.63E+03	6.05E+03	2.42E+04	6.05E+04	7.26E+04	9.68E+04	1.21E+05	
Cs-137	1.92E+02	4.79E+02	7.18E+02	1.20E+03	4.79E+03	1.20E+04	1.44E+04	1.92E+04	2.39E+04	
I-131	1.19E+02	2.99E+02	4.48E+02	7.47E+02	2.99E+03	7.47E+03	8.96E+03	1.19E+04	1.49E+04	
Ir-192	1.90E+03	4.75E+03	7.13E+03	1.19E+04	4.75E+04	1.19E+05	1.43E+05	1.90E+05	2.38E+05	
Po-210	1.06E+01	2.66E+01	3.99E+01	6.65E+01	2.66E+02	6.65E+02	7.97E+02	1.06E+03	1.33E+03	
Co-60	7.62E+02	1.90E+03	2.86E+03	4.76E+03	1.90E+04	4.76E+04	5.71E+04	7.62E+04	9.52E+04	

Drinking Water Risk for Specified Dose (mrem) Over Specified Time

		4	10	15	25	100	250	300	400	500
30	days									
Sr-90		1.59E-06	3.97E-06	5.96E-06	9.93E-06	3.97E-05	9.93E-05	1.19E-04	1.59E-04	1.99E-04
Y-90		1.68E-06	4.20E-06	6.30E-06	1.05E-05	4.20E-05	1.05E-04	1.26E-04	1.68E-04	2.10E-04
Cs-137		1.81E-06	4.54E-06	6.81E-06	1.13E-05	4.54E-05	1.13E-04	1.36E-04	1.81E-04	2.27E-04
I-131		8.40E-07	2.10E-06	3.15E-06	5.25E-06	2.10E-05	5.25E-05	6.30E-05	8.40E-05	1.05E-04
Ir-192		1.56E-06	3.90E-06	5.85E-06	9.74E-06	3.90E-05	9.74E-05	1.17E-04	1.56E-04	1.95E-04
Po-210		1.10E-06	2.75E-06	4.12E-06	6.87E-06	2.75E-05	6.87E-05	8.24E-05	1.10E-04	1.37E-04
Co-60		1.56E-06	3.89E-06	5.83E-06	9.72E-06	3.89E-05	9.72E-05	1.17E-04	1.56E-04	1.94E-04
60	days									
Sr-90		1.59E-06	3.97E-06	5.96E-06	9.93E-06	3.97E-05	9.93E-05	1.19E-04	1.59E-04	1.99E-04
Y-90		1.68E-06	4.20E-06	6.30E-06	1.05E-05	4.20E-05	1.05E-04	1.26E-04	1.68E-04	2.10E-04
Cs-137		1.81E-06	4.54E-06	6.81E-06	1.13E-05	4.54E-05	1.13E-04	1.36E-04	1.81E-04	2.27E-04
I-131		8.40E-07	2.10E-06	3.15E-06	5.25E-06	2.10E-05	5.25E-05	6.30E-05	8.40E-05	1.05E-04
Ir-192		1.56E-06	3.90E-06	5.85E-06	9.74E-06	3.90E-05	9.74E-05	1.17E-04	1.56E-04	1.95E-04
Po-210		1.10E-06	2.75E-06	4.12E-06	6.87E-06	2.75E-05	6.87E-05	8.24E-05	1.10E-04	1.37E-04
Co-60		1.56E-06	3.89E-06	5.83E-06	9.72E-06	3.89E-05	9.72E-05	1.17E-04	1.56E-04	1.94E-04
90	days									
Sr-90		1.59E-06	3.97E-06	5.96E-06	9.93E-06	3.97E-05	9.93E-05	1.19E-04	1.59E-04	1.99E-04
Y-90		1.68E-06	4.20E-06	6.30E-06	1.05E-05	4.20E-05	1.05E-04	1.26E-04	1.68E-04	2.10E-04
Cs-137		1.81E-06	4.54E-06	6.81E-06	1.13E-05	4.54E-05	1.13E-04	1.36E-04	1.81E-04	2.27E-04
I-131		8.40E-07	2.10E-06	3.15E-06	5.25E-06	2.10E-05	5.25E-05	6.30E-05	8.40E-05	1.05E-04
Ir-192		1.56E-06	3.90E-06	5.85E-06	9.74E-06	3.90E-05	9.74E-05	1.17E-04	1.56E-04	1.95E-04
Po-210		1.10E-06	2.75E-06	4.12E-06	6.87E-06	2.75E-05	6.87E-05	8.24E-05	1.10E-04	1.37E-04
Co-60		1.56E-06	3.89E-06	5.83E-06	9.72E-06	3.89E-05	9.72E-05	1.17E-04	1.56E-04	1.94E-04
365	days									
Sr-90		1.59E-06	3.97E-06	5.96E-06	9.93E-06	3.97E-05	9.93E-05	1.19E-04	1.59E-04	1.99E-04
Y-90		1.68E-06	4.20E-06	6.30E-06	1.05E-05	4.20E-05	1.05E-04	1.26E-04	1.68E-04	2.10E-04
Cs-137		1.81E-06	4.54E-06	6.81E-06	1.13E-05	4.54E-05	1.13E-04	1.36E-04	1.81E-04	2.27E-04
I-131		8.40E-07	2.10E-06	3.15E-06	5.25E-06	2.10E-05	5.25E-05	6.30E-05	8.40E-05	1.05E-04
Ir-192		1.56E-06	3.90E-06	5.85E-06	9.74E-06	3.90E-05	9.74E-05	1.17E-04	1.56E-04	1.95E-04
Po-210		1.10E-06	2.75E-06	4.12E-06	6.87E-06	2.75E-05	6.87E-05	8.24E-05	1.10E-04	1.37E-04
Co-60		1.56E-06	3.89E-06	5.83E-06	9.72E-06	3.89E-05	9.72E-05	1.17E-04	1.56E-04	1.94E-04